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THE GATHMAN SHELL EXPERIMENTS at Sandy Hook, for testing the use of high explosives in ordinary guns, seem to promise success. Some days ago an old Rodman 15-in. gun was loaded with a Gathman shell containing 100 lbs. of guncotton, and then buried 20 ft. in sand. The firing charge was exploded by electricity after the bore of the gun had been packed with sand and stone, and the gun was blown into fragments. These fragments are now being dug out and examined; three much-battered pressure gages have been recovered showing pressures of 78,000 lbs. per sq. in.; the bronze base of the Gathman shell was in the breech end of the gun, and a portion of the forward end of this shell had lodged in the sand 3½ ft. from where the muzzle of the gun had been. The most interesting part of the experiment is that considerable quantities of unexploded guncotton have been recovered from the sand. This is assumed to show that while the Gathman detonator exploded, the fuse arrangement protected the guncotton from explosion. This fuse is practically a device for separating the detonator from the guncotton until the shell begins to revolve in its flight; centrifugal force then comes into play to turn these iron plugs and open a passage for the gases to the guncotton. The shell will then explode either by impact or it can be arranged for a time fuse.

AN ATLANTIC FREIGHTER, especially designed for Manchester Canal Service, was recently launched at Jarrow, by the Palmer Ship-Building & Iron Co. This is a steel cattle and cargo steamer, built for the Manchester Line running to Canada. The "Manchester Port" is 467 ft. long, 52 ft. beam, 39 ft. deep and 14,500 tons displacement. She has three decks, nine watertight compartments, all extending to the upper deck; four masts, with telescopic foremasts and funnels to enable her to pass under canal bridges. The engines are inverted triple-expansion, with 30, 50 and 82½-in. cylinders and 54-in. stroke. She can carry about 700 head of cattle. A sister ship, the "Manchester Merchant," is nearly ready to launch.

THE VAUXHALL BRIDGE, over the Thames in London, is being demolished to make room for a new structure. The old bridge was built in 1809-'14, and consisted of nine arch spans of 80 ft. each, with ten cast-iron ribs in each arch, each rib weighing about 15 tons. The roadway was laid on cast plates, supported on cast-iron posts resting on the ribs.

THE ATBARA RIVER BRIDGE for the Soudan Ry. will have seven pin-connected through spans of 147 ft., c. to c. of end piers. The trusses are 16 ft. 2 ins. apart, and are connected by 43-in. plate girder floor beams riveted between the posts. There are seven panels, and the posts and chords are built up of pairs of steel channels connected by lathing. Eyebars and adjustable rods are used for the diagonal bracing. The portal bracing and top and bottom lateral systems are of angle irons, with substantial connections. Two plate girder stringers run between the floor beams and carry the ties, which are 6 × 10 ins. The depth of truss is 21 ft. 6 ins., with a clear width of 14 ft. and a clear headway of 16 ft. The erection will be carried on from a steel-framed traveler, 30 ft. high, running on the tops of the trusses, and having two steel booms 44 ft. 3 ins. long projecting in front. The bridge was designed, built and erected by the Pencoyd Iron Works, Pencoyd, Pa., and in view of the charges made by some of the English bridge builders (Eng. News, April 13, 1899), that the American firm enjoyed special advantages from the Egyptian government through prior information; and that the seven spans were delivered either wholly or partly out of stock, etc., the following statement from "Engineering," of London, is of interest: On Jan. 7, 1899, the London agents of the Egyptian government telegraphed the Pencoyd Co., enquiring if it would compete; Jan. 24 the Pencoyd Co. received the plans and specifications; Jan. 27 the Pencoyd Co. telegraphed an offer to London which was accepted by cable; March 7 the steelwork for the whole seven spans complete was shipped on the "Manhattan" and "Europe" to Alexandria. The total weight of the steel was 800 tons. The seven spans were constructed in 32 days, and six days should be deducted from this for a storm which cut off the coal supply from the works for a week. Every ton of steel in this bridge was made in the works after the contract was accepted.

THE GOKTICK VIADUCT, in Burmah, has been awarded to an American firm, and the Indian Government has been asked in the House of Commons why this work did not go to an English manufacturer. The reply was that the work was let by the Burmah Railway Co., not by the Indian Government, and six British and two American firms were invited to compete. Four of the British firms declined, and the most favorable English tender required three years for completion of the work at a cost of $580,000; while the best American bid proposed to finish the work in one year for $300,625. Lord George Hamilton, in making this reply for the Indian Government, added that the Indian railways always gave preference to British manufacturers; but in the face of the too frequent marked difference in cost and time of delivery, between English and American tenders, common sense dictated the course pursued.

A RUSSIAN RAILWAY TO PEKIN is the meaning of a concession now demanded of the Chinese government by the Russian Minister. The proposition is to extend the Manchurian railway, already authorized, by a branch line reaching Pekin, and thus connecting that city with Port Arthur. The Chinese officials are said to be much troubled by the demand, and announce that they do not acquiesce in the Russo-British treaty as to spheres of influence in China, based on the principle that these two nations may enter into arrangements concerning Chinese territory without consulting China. Later advices say that the request for the railway extension has been refused.

THE OLD MEIGS ELEVATED RAILWAY CO. is suing the Boston Elevated Railway Co., to whom it claims that it sold the control. The plaintiffs claim that George H. Towle and F. C. Patch and other incorporators of the Boston Elevated Railway Co. were employed by them to amend the charter of their company; and that finally these agents sold a control in the old company to J. P. Morgan for $400,000, without the consent of the stockholders. The plaintiffs now want the money represented by this deal to be turned over to them, on the theory that they were associates and incorporators of the Boston company. The defence is that there was no tangible property involved, and the alleged agreement was ineffectual.

THE NEW YORK AND BROOKLYN RAILWAY CO. is applying to the New York Board of Aldermen for a confirmation of their grant to build a tunnel railway from New York to Brooklyn, approved by the Board of Aldermen and the then Mayor of New York, on Aug. 6, 1896. Under the old ordinance the route of the line was under Nassau, William, Gold, Cliff, Pearl, Water, Front and South Sts., and Pier 23; thence under the East River to a point near Fulton Ferry. The Brooklyn members oppose the scheme as one intended to block the Long Island Railway Co.'s project for a tunnel. It has been referred to the Committee on Railways.

THE MOST SERIOUS RAILWAY ACCIDENT of the week, and one of the worst which has happened in this country in recent years, occurred on the Philadelphia & Reading R. R., at Exeter, Pa., on the night of May 12. The latest reports place the number of killed at 30, while the number of injured is variously stated from 50 to 60, several of whom will undoubtedly die. The accident appears to have resulted from a slight accident to a freight train, which made it necessary to use one track for all traffic. The first train to run past the freight was an express bound for Williamsport, which was followed by an excursion train from Harrisburg, both filled with people returning from the unveiling of a monument. Owing to a sharp curve, the engineer of the express did not stop his train until he had passed the order signal by a train length. The train was backed up and a brakeman started back with red light. Almost instantly the excursion train, running as the second section of the express, rounded the curve at a high speed and crashed into the rear of the standing train with the disastrous results mentioned.

PERMISSION TO OPEN THE CHICAGO DRAINAGE Canal has been granted by the U. S. Government, subject to certain reservations. The order was issued on May 8 by R. A. Alger, Secretary of War, and John M. Wilson, Brigadier-General, Chief of Engineers, U. S. A. It opens by citing the River and Harbor act of March 3, 1899, which makes it unlawful to alter or modify the course, location, condition or capacity of the channel of any navigable waterway in the United States without the approval of the Secretary of War and Chief of Engineers. It next refers to the permission already granted the district to provide for a flowage of 300,000 cu. ft. per min. in the Chicago River, with a velocity of 1¼ miles an hour, and the representation of the district that the necessary movable dams and sluice gates to control the volume and velocity of the Chicago River have been provided, and finally authorizes the opening of the channel and the diversion of the Chicago River into it, as follows:

Therefore, the chief of engineers having consented thereto, this is to certify that the Secretary of War hereby gives permission to said Sanitary District of Chicago to open the channel constructed and cause the waters of Chicago River to flow into the same, subject to the following conditions:

That it be distinctly understood that it is the intention of the Secretary of War to submit the questions connected with the work of the Sanitary District of Chicago to congress for consideration and final action, and that this permit shall be subject to such action as may be taken by congress.

That if at any time it becomes apparent that the current created by such drainage works in the south and main branches of Chicago River be unreasonably obstructive to navigation or injurious to property, the Secretary of War reserves the right to close such discharge through said channel or to modify it to such extent as may be demanded by navigation and property interests along said Chicago River and its south branch.

That the Sanitary District of Chicago must assume all responsibility for damages to property and navigation interests by reason of the introduction of a current in Chicago River.

COMMISSIONERS TO INSPECT the Chicago Drainage Canal, to see if it complies with the conditions as to capacity laid down in the act authorizing the work, have been appointed by Governor Tanner as follows: John Lambert, of Joliet; A. F. Schoch, of Ottawa, and Isaac Taylor, of Peoria.

ST. LAWRENCE CANAL ESTIMATES for the fiscal year ending July 1, 1900, are given out as follows by the Dominion Government: Farrans Point Canal enlargement, $325,000 for 1899 and $90,000 for 1900; Galoups canal, including Iroquois, Cardinal and upper entrance enlargement, 1899, $1,225,000, 1900, $688,400, North canal, deepening and straightening, 1899, $250,000, 1900, $55,000; Galoups rapids, removing obstructions, 1899, $50,000, 1900, $50,000; Rapid du Plat canal, enlargement, 1899, $60,000, 1900, $92,500.

POLLUTION OF THE WATER SUPPLY of Philadelphia is attributed by Mr. J. Lewis Good, Acting Chief of the Bureau of Health, to storm sewers serving a populous district and discharging into Wissahickon Creek and Schuylkill River from one to two miles above the intake of the Queen Lane pumping station. Many hundreds of houses in this district are not connected with the sewers. Their wastes, both liquid and solid, are all deposited on or near the surface of the ground, and find their way, to a large extent, to the storm sewers; either very soon after being thrown out, or after the first rain. The report in which these facts are given also states that the number of cases of typhoid fever in Philadelphia is greatly diminishing.——The bill appropriating $20,400 for repairs to the pumping engines has been passed by councils and signed by the mayor.

LICENSES FOR THE SALE of spring and mineral waters at Albany, N. Y., will be required hereafter. The licenses will be issued by the local board of health, which has drawn a set of rules to govern this business in the interest of the public health.

ELECTRIC TRACTION in the Keeling mine at Pittsburg, Pa., is described in a paper recently presented before the American Institute of Mining Engineers by Mr. F. Z. Schellenberg, of Pittsburg. Two Westinghouse-Baldwin locomotives are used, weighing about 25,000 lbs., and each equipped with two 50-HP. motors. There are seven miles of track of 39-in. gage, laid with 40-lb. rails, the entries being 8 ft. 6 ins. wide and 5 ft. 6 ins. high. Each locomotive hauls a train of 30 loaded cars (or 60 tons) up a maximum grade of 1%, and makes a speed of about eight miles per hour. Of the 25,000 lbs. on the driving wheels, 15% is exerted at the drawbar. The pull on good level track is 10 lbs. per ton for the locomotive and 18 to 20 lbs. per ton for the mine cars, but with inferior roadbed and track and common mine cars in bad repair, a pull of 40 lbs. per ton on level track is the initial rating, before considering the effect of the grade. The power plant consists of two Fischer engines, belted to two Westinghouse direct-current, multipolar dynamos of 100-K-W. capacity each, at 250 to 300 volts. The current is used also for electric lighting, and is being tried for operating coal-cutting machines.

$76.48. Or a single reservoir may be constructed, storing on Schroon and Brant lakes a total of 15,925,000,000 cu. ft., at an approximate cost of $840,000, or at $52.12 per million cubic feet stored. At Piseco Lake it was estimated that a storage of 1,725,000,000 cu. ft. could be made for $70,000, or for $40 per million cubic feet stored. At Indian Lake it was estimated that a storage of 4,468,000,000 cu. ft. could be made for $120,000, or at the rate of $26.86 per million cubic feet stored. As will be shown farther on, the actual construction just completed at Indian Lake has abundantly justified the original estimate, although it is believed from additional information gained by the surveys of 1896 that some of the other reservoirs were underestimated and that moderate corrections in the figures should be made. Even when such corrections are made, it still remains true that water storage in the Adirondack region can be made much cheaper than in any other portion of the State of New York.

Lumbering operations began in the vicinity of Indian Lake about 1845, in which year a dam was erected, which has been maintained continuously ever since, for the purpose of furnishing water for driving logs. The original dam raised the water surface between 5 and 6 ft.; this was subsequently increased in rebuilding the dam to between 10 and 11 ft. The lake itself (before these constructions were made) was about two miles in length and from 1,500 to 1,800 ft. in width at the widest portion. The effect of raising the water 10 ft. was to make a body of water over nine miles in length three-quarters of a mile wide at the widest portion, as shown by Fig. 3, there being extensive low swamp areas at the upper end of the lake, which were flooded by the rise of 10 ft. The present construction raises the water 23 ft. above the crest of the old timber dam, or between 33 and 34 ft. above the mean surface of the original lake, and overflows additional flat areas at the upper end of the lake to such an extent as to make a body of water 14.3 miles in length, with two bays with lengths of 2 miles and 3¾ miles, respectively. The drainage area tributary to the lake above the dam is 146 sq. miles. At the original raising of the water in 1845 the timber was left standing on the flat areas flooded, as was also done when later on the original dam was rebuilt and raised to an additional height. After two or three years this timber died and remained standing for many years, a serious blot on the landscape. About fifteen years ago the great bulk of it had fallen down, and since that time, aside from a few scattering stubs here and there, the old reservoir when full has presented the appearance of a fine natural lake. Generally the shores above the new flow line created by the 10-ft. rise are bold and rocky, so that aside from an arm about 7.5 miles in length extending up the Jessups River, one of the main tributaries, there is very little flat land to be flooded by the new construction. The new work has included the cutting of all the timber around the margins up to the new flow line, as indicated in Fig. 3, a total area amounting to 1,160 acres, of which 450 acres are in the flat areas on the Jessups River, the balance being distributed around the margin of the lake. The total length of margin, including the Jessups River, is about 35 miles.

The area of Indian Lake proper (the original lake) is about 1,000 acres. The area at level of crest of old timber dam is 3,007 acres. The area at 23 ft. above the old timber dam, or at the new flow line, is 5,035 acres.

The storage of the timber dam, which has been replaced by the new masonry dam, is estimated at 800,000,000 cu. ft.

For a number of years public opinion in the State of New York has been rapidly focusing upon State ownership of the wild Adirondack area as the proper place for a great State park. As bearing in this direction the Legislature, in 1893, passed an act erecting the Adirondack Park and defining its limits. This act provided that the park so created—

> Shall be forever reserved, maintained and cared for as ground open for the free use of all the people for their health and pleasure, and as forest lands necessary to the preservation of the headwaters of the chief rivers of the state, and the future timber supply, and shall remain part of the Forest Preserve.

The Adirondack Park, as defined by the Act of 1893, has an area of 2,800,000 acres, of which the State had possession from tax titles, etc., in 1897, of about 661,000 acres. Governor Black, recognizing the importance of adopting a definite and comprehensive plan which should conserve the future water and timber supply of the State as contemplated in the Adirondack Park Act of 1893, recommended in his annual message to the Legislature of 1897 the passage of "An act to provide for the acquisition of land in the territory embraced in the Adirondack Park, and making an appropriation therefor." Under this act $1,000,000 was appropriated in 1897 and $500,000 in 1898. It is expected that the Legislature of 1899 will appropriate $300,000.

This act also created the Forest Preserve Board, to consist of three persons selected from the Commissioners of Fisheries, Game and Forest and the Commissioners of the Land Office. This board may enter upon and take possession of any land, structures and waters in the territory embraced in the Adirondack Park, the appropriation of which in its judgment shall be necessary for the purposes specified in the act of 1893. The first Commissioners appointed were Timothy L. Woodruff, Lieutenant-Governor; Campbell W. Adams, State Engineer and Surveyor; and Charles H. Babcock, member of the Fisheries, Game and Forest Commission. The Commission still remains as originally constituted, except that E. A. Bond, State Engineer and Surveyor, has succeeded Campbell W. Adams, whose term expired Dec. 31, 1898.

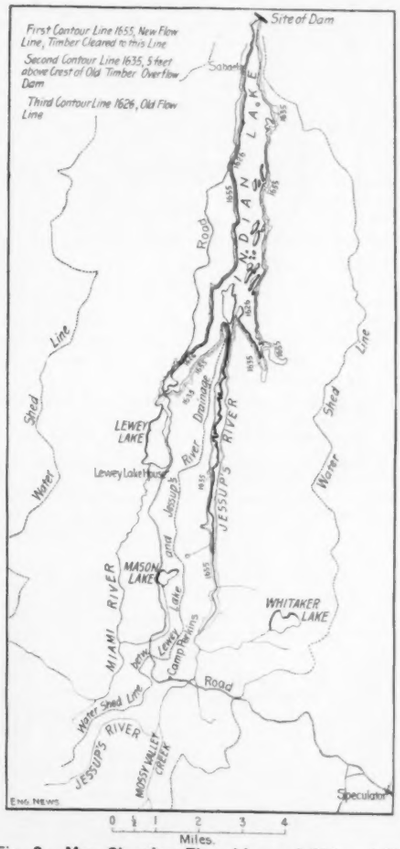


Fig. 3.—Map Showing Flow Lines of Old and New Lake, Area of Cleared Land and Part of Drainage Crest.

The old timber dam at the foot of Indian Lake being badly in need of repair, the owners thereof proposed, in the spring of 1898, to rebuild the same. While making arrangements looking toward such rebuilding it was found that the Forest Preserve Board desired to acquire Townships 15 and 32 in the Totten and Crossfield purchase, within the limits of which Indian Lake was situated. The reason for this purchase was that the State already had considerable holdings in that vicinity and bordering on these two townships, and in consequence their purchase would make a very extensive body of State lands in that vicinity. In its first annual report, transmitted to the Governor on Jan. 29, 1898, the Forest Preserve Board makes the following statements in regard to the purchase of the lands at and about Indian Lake:

> The largest acreage bought of any one party was that in Townships 15 and 32, Totten and Crossfield purchase, Hamilton county, which was purchased from the Indian River Co. This purchase included, with the exception of a few small lots previously sold to other parties, all of Township 15, and three-fourths of Township 32; in all, 42,000 acres. The price paid was $164,000, or $3.90 per acre. These lands include the shores of Indian Lake, and the dam at its outlet. The lake is over 11 miles in length. Originally it was much smaller, about three miles long; but a dam, built at its outlet, raised the water until the backflow extended its surface to its present area. As the dam was built many years ago, the trees around the shore of the lake which were then killed by the overflow, had gone out over the dam. The wooded growth along the shore has adjusted itself to the changed conditions, leaving nothing in sight to indicate that the present boundaries of this beautiful lake were not the original ones. But if the dam, which was a wooden one, should be allowed to decay and fall to pieces, the water would be drawn down to its former level, reducing the lake to one-third its present size, and leaving miles of devastated flats. In 1893, the Forest Commission, in its annual report, said:
>
> "The beauty of this lake and its present area is dependent on the dam at its outlet. The damage and unsightly views once caused by it are matters of the past. If the dam were destroyed and the water allowed to fall, the upper portion of the lake would be changed into a dismal swamp, interspersed with slimy pools and rotting stumps. Now that the dam has been built, and the scenery has recovered from its effects, it should be maintained at its present height. If this can be done in no other way, the state should do it at public expense. It would furnish an immense reservoir for the Hudson, and any variation in depth incidental to reservoir purposes would in no way effect the beauty of the steep banks."
>
> At the time the board purchased this tract of land, a contract had been made by the owners for the construction of a permanent stone dam to replace the decaying wooden one, and the price finally agreed upon was based upon a consideration of the advantages gained in thus not only preventing the destruction of Indian Lake in all its beauty, but also in preserving it as a vast reservoir for supplying the Champlain Canal, and improving the navigation of the Hudson River.
>
> It is to be noted in this connection that the control of the flow of the waters has been thus secured to the state rather than left in the hands of private parties.

The permanent stone dam referred to by the Forest Preserve Board in the foregoing quotation as the one for the construction of which a contract had been made, is the new dam herewith described, the board's authority for such purchase being derived from Section 3 of the act creating the Forest Preserve Board, which empowers them to enter on and take possession of any land, structures and waters in the territory embraced in the Adirondack Park, etc. It will be patent to any person giving the subject even casual consideration that the portion of the Adirondack region included in the Adirondack Park is of value for only two purposes, viz.: for a State park worthy of the great Commonwealth of New York, and for the conservation of the issuing streams by the construction of large storage reservoirs. It is highly creditable to the Forest Preserve Board that it has been possible for it to inaugurate these two great enterprises, both of which are certain to be of the greatest possible value to the citizens of New York. The park and the storage reservoirs are in the line of fully utilizing this region for the only two things for which it is really useful.

Considering the vast amount of manufacturing in the State of New York, it has always seemed to the author extraordinary that the great natural water resources of the State had not been more thoroughly utilized by storage reservoirs in this region long before the present time. The reasons why they have not he has given in detail elsewhere, and he simply contents himself in this place with the foregoing congratulation to the Forest Preserve Board for making a successful beginning of this exceedingly important work.

The original surveys for the Indian River dam and reservoir were made by Wallace Greenalch, Jun. Am. Soc. C. E., in the fall of 1895. Additional surveys at the dam site were made by Foster B. Morss, M. Am. Soc. C. E., in 1896 and 1897. The plans for the dam as constructed in 1898 were prepared by the author in the fall of 1898. The Hon. Campbell W. Adams, State Engineer and Surveyor, was, by virtue of his position as a member of the Forest Preserve Board, ex-officio Chief Engineer. The work was built in 1898 under the supervision of the author as engineer, with Mr. Greenalch as assistant engineer. The paper herewith appended, describing the construction of the dam, has been prepared by Mr. Greenalch,

THE INDIAN RIVER DAM.

(With two-page plate.)

By George W. Rafter, Wallace Greenalch and Robert E. Horton.

General Description.

By George W. Rafter, M. Am. Soc. C. E.

The Indian River Co. has recently completed a masonry dam (Figs. 1 and 2) about 47 ft. in height at the foot of Indian Lake, in Hamilton County, N. Y., which, on account of the large amount of storage gained with moderate expenditure, is deemed worthy of brief description. The dam creates an effective storage on Indian Lake of about 4,468,000,000 cu. ft. up to the level of the spillway crest, or, if we admit the use of flash boards 1 to 2 ft. in height, a storage may be expected of, roundly, 5,000,000,000 cu. ft.

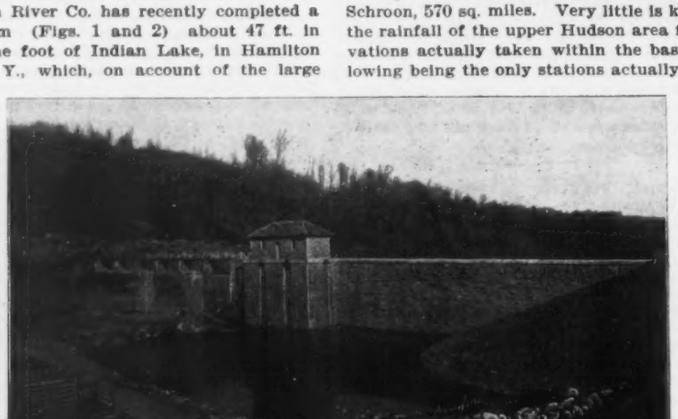


FIG. 1.—INDIAN RIVER DAM, LOOKING DOWN STREAM.
Geo. W. Rafter, M. Am. Soc. C. E., Engineer-in-Charge; McDonough, Cunningham & Howland, Contractors.

Before proceeding to the main description we may give, by way of illustrating the whole matter, the main facts as to water storage in the Adirondack region.

Chapter 599 of the Laws of New York of 1895 directed that the State Engineer and Surveyor, acting in conjunction with the Superintendent of Public Works, should, as soon as practicable, make a survey of the upper Hudson valley in order to determine what lakes, ponds and river valleys could be improved by the construction of storage dams in order to provide additional water for:

(1) The use of the Champlain canal.

(2) For restoring to the water power of the Hudson River water diverted for canal purposes

(3) Water for improving the navigation of the lower Hudson River.

The main branches of the Hudson River rise in the elevated mountain region of Essex and Hamilton counties. The whole region is rugged and mountainous, and was originally covered with heavy forests. The forest area has, however, been considerably reduced by lumbering operations in the last forty or fifty years, and by severe forest fires which have in places run over very extensive areas. Aside from a considerable summer population of tourists, the whole upper Hudson valley is sparsely populated, there being little opportunity for farming. The occupation of the great bulk of the people is lumbering. The cleared area is in consequence only a small per cent. of the whole.

The extreme headwaters of the Hudson River in Essex County drain from the southern slope of the highest mountains of the State, viz.: Mount Marcy, 5,344 ft.; Mount McIntyre, 5,112; Mount Skylight, 4,920; Nipple Top, 4,620; Dix Mountain, 4,842. This is a wild, uninhabited region of mountains, forests and lakes. The branches of the Hudson to the west, the Cedar and Indian Rivers, etc., drain a nearly equally wild, very sparsely inhabited country, but of somewhat less altitude, Snowy Mountain, the principal peak of the Indian lake region, being somewhat over 4,000 ft. above tide.

The upper Hudson valley may be considered as beginning at the mouth of the Mohawk, tide water having, previous to the construction of the Troy dam, reached that point. The catchment area above the mouth of the Mohawk is 4,627 sq. miles, and above Glens Falls, where the upper valley may more properly be taken to begin, it is 2,800 sq. miles.

The main tributaries of the Hudson above the Mohawk are the Hoosic, with a drainage area of 711 sq. miles; Batten Kill, 438; Sacundaga, 1,057; Schroon, 570 sq. miles. Very little is known as to the rainfall of the upper Hudson area from observations actually taken within the basin, the following being the only stations actually within the catchment area, and these are all in the southern part, South Hartford and Gloversville being just on the boundary:

Glens Falls.—Elevation, 340 ft. above tide; average rainfall for 20 years, 37.76 ins.

Kings Station.—Elevation, 588 ft.; average rainfall for 8 years, 45.24 ins.

South Hartford.—Elevation, 500 ft.; average rainfall for 13 years, 40.65 ins.

Gloversville.—Elevation, 850 ft.; average rainfall for 6 years, 46.10 ins.

Keene Valley (a short distance north of the north end of the upper Hudson catchment area).—Elevation, 1,000 ft.; average rainfall for 18 years, 35.93 ins.

Saranac Lake (also a short distance north of the Hudson catchment area).—Elevation, 1,540 ft.; average rainfall for 6 years, 37.90 ins.

Waterford (near Troy).—Elevation, 50 ft.; average rainfall for 4 years, given as 36.62 ins.

Albany.—Elevation, 97 ft.; average rainfall for 73 years, 39.38 ins.

In discussing questions relating to rainfall in the upper Hudson catchment area, it has been the author's custom to take as best applying to the entire basin the rainfall of the Northern Plateau as used by the State Meteorological Bureau, the stations included therein being Elizabethtown, Keene Valley, Lake Placid, Saranac Lake, Gloversville, Little Falls, North Lake, Lowville, Number Four and Kings Station. The monthly means derived from taking the averages at all these stations is considered to give a very close approximation to the mean monthly rainfall of the upper Hudson area. Proof of this proposition is derived from considering the relation between rainfall and runoff of that portion of the upper Hudson area above Mechanicville, where a fairly careful runoff record has been kept for the eleven years from 1888 to 1898, inclusive. In the first place it may be pointed out that, with the present precision of weir measurements, runoff data derived from actual gagings are likely to be more accurate than rainfall data. If for any given stream where rainfall and runoff data are available we arrange the yearly quantities in the order of the magnitude of the rainfalls and without reference to sequence of years, as per the following tabulation, we find that there is a clear relation between the rainfall in any given year and the runoff of that year. Plotting the rainfall as abscissas and the runoffs as ordinates, we may construct what may be termed the runoff curve of any given stream. Drawing such curve, we find that the runoffs for given rainfalls will group themselves above and below the curve, the extent of the departures from a true curve depending upon the accuracy of the data. If there are wide variations, we may conclude that there are large errors, either in the rainfalls or the runoffs, or both. If, on the contrary, the points all fall very nearly in the curve, we are justified in assuming the essential accuracy of the data. Judged by this standard, the rainfall and runoff data of the Hudson River are exceedinly accurate. From this point of view they give, so far as the author is aware, more nearly the true values than any extended set of gagings from so large an area thus far made. The following are the rainfalls and runoffs for the eleven years, from 1888 to 1898, inclusive, arranged in the order of the magnitude of the rainfalls:

Year.	Rainfall, ins.	Runoff, ins.	Year.	Rainfall, ins	Runoff, ins.
1892.....	53.87	33.08	1891.....	42.96	20.56
1890.....	50.35	28.56	1889.....	42.96*	21.71
1898.....	48.30	27.65	1893.....	42.18	21.91
1897.....	46.51	26.19	1894.....	41.37	19.37
1896.....	45.21	23.65	1895.....	36.67	17.46
1888.....	43.92	23.64			

*Probably 42.96 ins. rainfall for 1889 is only approximately correct. Data incomplete.

The studies of the possibilities of storage in the Adirondack region indicate that reservoirs may be made on lakes and in river valleys of the upper Hudson area with a total storage of over 44,000,000,000 cu. ft. Probably when the investigation is fully complete this figure will be considerably increased, but just how much cannot now be stated for lack of the definite data to be drawn from topographical surveys. The investigations made in 1895-6 showed that, taking into account the distribution and quantity of rainfall, reservoirs could be safely constructed in the upper Hudson catchment area storing 13.5 ins. over the entire area. The argument on which this conclusion is based may be found in the author's report on the upper Hudson surveys made to the State Engineer and Surveyor under date of Dec. 31, 1895, and published as an appendix to the annual report of the State Engineer and Surveyor for the year ending Sept. 30, 1895. The investigations made also showed that, generally speaking, reservoirs could be constructed in the Adirondack region much cheaper than in other parts of the State of New York. The original estimated cost of a system of small reservoirs for the Schroon valley is $1,172,500, which gives, for a total storage of 15,330,000,000 cu. ft., a cost per million cubic feet stored of

FIG. 2.—LOOKING ACROSS INDIAN RIVER DAM.

while the paper describing the work of clearing is by Mr. Robert E. Horton, who was second assistant on the work.

The specifications for this work embody a few points of possible interest. Among others we may cite the specification for the clearing of the reservoir margin, wherein it is provided:

That all timber and brush of every sort, kind and description now standing on the banks of the Indian River or Lake, above the site of the proposed dam, and between the present margins of the said river and lake and a line 10 ft. vertically above the new flow line, shall be cut to within 2 or 3 ft. of the ground and thoroughly burned or disposed of by cutting into logs, fire-wood or other merchantable timber. The right is also reserved to make the upper limit of the clearing 5 ft. above the ordinary water level instead of 10 ft., as just specified. The limit of the clearing will be staked out by the engineer, and the contractor must carefully preserve all stakes set to indicate said limits. In any case, all the timber included within the limit included by the stakes will be considered the property of the contractor, but any of it, which he wishes to utilize or save must be entirely removed beyond the limits of the work before the expiration of the contract. All timber not so excepted by the contractor and removed by him must be piled in proper windrows and completely burned. In general the area on which the said timber is situated is on side hill slopes and the timber may be conveniently windrowed down the hill toward the water. . . . . Along the line of the new margin as wide a space as possible must be cleared of timber, tree tops, brush, etc., and at least four furrows plowed to prevent the spreading of fire. In any case the contractor will use all and every precaution against the spreading of fire during the period of burning, and any damage which may be caused by the fire spreading into adjoining areas must be borne by him.

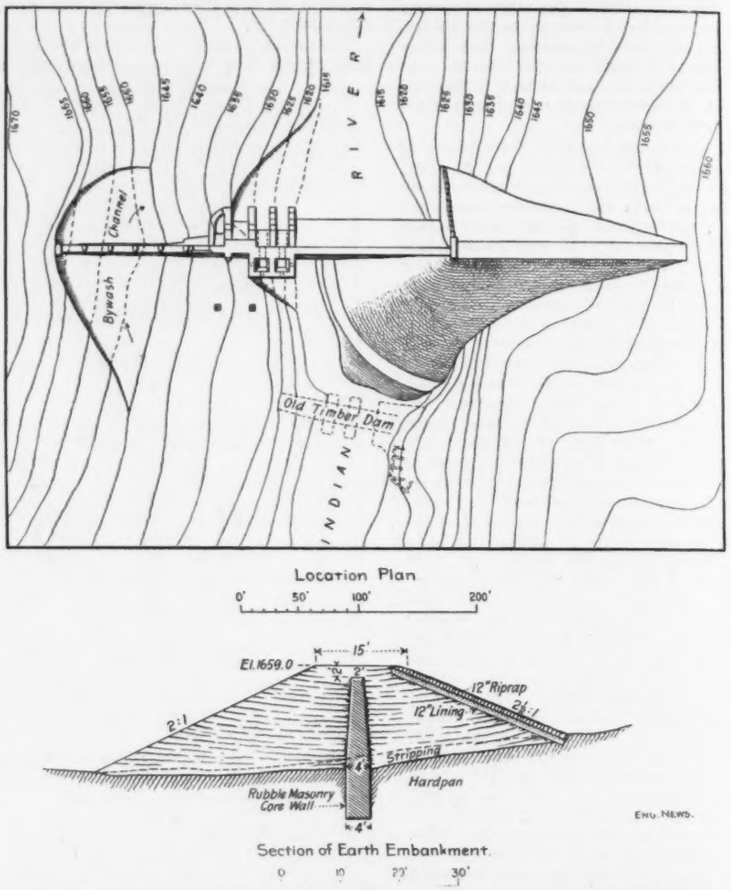
Under this specification the timber has been cut from the entire area and about 850 acres burned over. The burning, so far as carried, has been accomplished without serious damage to the adjoining forest, although in two cases the fire escaped into the forest area and did a small amount of damage. One outcome of the work was to show that it is exceedingly difficult to burn the bodies of the trees. Whenever this was attempted a mass of fire was made which held for several days, and was very liable to run outside the limits of the clearing whenever the wind blew strongly from off the lake. This point being satisfactorily determined by several trials, certain slight modifications of the specifications were made. Among others it was concluded better to not attempt to burn the heavy timber, but rather to, so far as possible, float it out after the reservoir has become full. The brush and tree tops, on the contrary, were easily burned, they making a quick fire which burned itself out very soon after being started. These points are referred to in somewhat greater detail in the accompanying paper on the clearing, by Mr. Horton.

It has seemed proper to the author to go into this matter of the methods used and results obtained in clearing the margins somewhat more extensively than would otherwise have been done because, so far as known to him, no such extended clearing of a reservoir margin in the forest area has been previously carried out in this State. Generally those citizens who go to the woods for health and pleasure have justly considered the leaving of the standing timber about the margins of new reservoirs a great detriment, and in order to meet the natural opposition of those holding this view every attempt has been made to have the clearing at Indian Lake well done. The non-completion of the burning during the year 1898 is due entirely to the fact of constant rains during the months of October and November, in which months it would have otherwise been completed.

The specification for the construction of the dam was drawn on the theory of so far as possible fully utilizing the available local material. In regard to this material it may be stated that syenite of proper quality for the faces of the dam, gate house masonry, spillway, etc., was quarried on the banks of the lake only a few hundred feet away, while the excavation for the spillway on the north side furnished a large amount of excellent aggregate material for concrete, as well as broken stone for lining and larger stone for riprap. The preliminary investigations having shown that an abundance of these different materials would be available, it was considered to be desirable to build the earth embankment at the south end, allowing the toe of the slope to run down along the back of the dam, rather than to make a wing wall on the back side at that end, the paving of the slope permitting the use of a considerable amount of material which would otherwise have gone to waste. It is believed that a small economy has resulted from this procedure.

The cement was specified to be American Portland cement from manufacturers of established reputation, of a quality satisfactory to the engineer, who was empowered to establish standards for tests applying specially to this work, or in case of not establishing any special tests the cement generally should be of

such a degree of fineness that 95% would pass through a sieve of 2,500 meshes per sq. in., and 90% through a sieve of 10,000 meshes per sq. in. When mixed neat and exposed one day in air and six days in water to withstand a tensile strain of not less than 400 lbs. per sq. in., and when mixed in the ratio of 3 lbs. of clear, sharp sand to 1 lb. of cement, exposed one day in air and six days in water, to withstand a tensile strain of not less than 125 lbs. per sq. in. Briquettes made of neat cement must not



Location Plan

0' 50' 100' 200'

Section of Earth Embankment.

0 10 20' 30'

FIG. 4.—GENERAL PLAN OF DAM AND SECTION OF EARTH EMBANKMENT.

set to the extent of supporting a 1-12-in. wire with a ¼-lb. load in less than 15 minutes. Also briquettes of neat cement must not show cracks or checks when immersed in water for seven days after mixing. Cement may also be subjected to a hot test when deemed necessary by the engineer. . . . Contractor will be required to furnish a small, rough board building or room on the work for cement testing, furnished with shelving, racks, benches and work table to the satisfaction of the engineer. A steam pipe must be run into the same and sufficient heat furnished to prevent freezing either during the day or at night in cold weather. The expense of such, together with the fitting up and warming of the same, must be included in the whole work.

The cement used was the Iron-Clad brand of the Glens Falls Portland Cement Co. The contractors were very anxious to use the Victor brand of the same firm, but after some study of the matter it was concluded that inasmuch as the Victor brand was in reality a sand-silica cement, it did not answer the specification requirement of an American Portland. In order to avoid future contention as to whether a sand-silica cement is really a Portland cement, the author proposes in the future to specify a a "pure" American Portland cement "free from all adulteration of every sort and kind." There is no doubt in his mind but that the sand-silica cements should be sold on their merits and not in any degree as Portland cements.

The essential features of the concrete specification are as follows:

Concrete will be made of Portland cement mortar, 3 parts of sand to 1 of cement, and of aggregate material to be obtained from the foundation and bywash excavation. In regard to the use of materials from the foundation and bywash excavations, the contractor will understand that the intention is to carefully utilize all local material so far as the same may be found available when the excavations are fully opened up. The uncertainty as to just how the excavated material will work renders it impossible to decide in advance the proportion of concrete that may be used in the backing masonry.

The aggregate material shall consist of clean fragments of the local stone broken to such size as will pass freely, in largest dimensions, through a 2-in. ring. In case gravel can be found in the vicinity, and if so directed by the engineer, a certain proportion of the concrete shall consist of clean gravel ranging in size from gravel stone, capable of passing through a 1-in. ring, down to pebbles not smaller than ¼-in. in diameter, or thereabouts. . . . All of the aggregate material must be free from dirt, earth, clay or other improper substances. If required by the engineer, it shall be washed before being mixed with any cement mortar. In forming concrete such a proportion of mortar of the specified composition will be used as may be found necessary by trial to a little more than fill the voids in the aggregate. Tests of the voids will be made from time to time under the direction of the engineer and instructions given as to the per cent. of mortar of the specified composition to be used. For the information of the contractor in the way of computing the cost of concrete of the quality herein required, it may be stated that ordinarily the per cent. of mortar will be about 33% of the measured volume of the aggregate. In case of the use of a certain proportion of gravel or tailings in the aggregate, the proportion of mortar may be reduced to somewhat less than 30%. . . . In warm weather aggregate material shall be wet a short time before using. In case of using concrete in the backing other than for filling spaces between large stones, it will be built in large blocks with spaces of from 1 to 2 ft. between and breaking joints one upon the other irregularly, as may be directed by the engineer. . . . Contractor will take all necessary precautions for protecting fresh concrete from the effect of the sun during warm weather, or against freezing in cold weather. In warm weather the freshly laid concrete, when required by the engineer, shall be fully protected by the use of tarpaulins or canvas coverings. Shall also be thoroughly wet with water several times a day, as may be required by the engineer.

Perhaps as interesting a feature as any connected with the Indian Lake dam is the result of the letting of the work. Messrs. McCaghey & Linehan, of Sandy Hill, N. Y.; Flood & Sherrill, Sandy Hill, N. Y.; J. Whalen & Co., Whitehall, N. Y.; and McDonough, Cunningham & Howland, Troy, N. Y., were all asked to visit the site of the proposed work and submit tenders for its construction. This request was complied with by the first three mentioned. At that time Messrs. McDonough, Cunningham & Howland had bids aggregating several hundred thousand dollars for State work in the hands of the Superintendent of Public Works, and which they expected would be award-

ed to them very soon. They therefore felt that they would not be able to undertake additional works that year. However, a short time before the day set for receiving the Indian River dam bids they learned that the contracts for the State work would not be awarded to them because of shortage in the $9,000,000 fund provided by Chapter 79 of the Laws of 1895. At least four days' time was required to visit Indian Lake and make the necessary study of the ground, and the particular question with Messrs. McDonough, Cunningham & Howland was how they could obtain the information and still have their bid in on time. The undersigned therefore furnished them with all the information which he had obtained from his careful study of the matter on the ground, at the same time placing the said information at the disposal of the other competing firms. The total of Messrs. McDonough, Cunningham & Howland's bid made under these circumstances was $85,278, while the next to the lowest bid, that of Flood & Sherrill, was $137,430, J. Whalen & Co. bidding $144.315.50, and McCaghey & Linehan, $144,750. The author's estimate for the work tendered for, including cost of engineering, was $95,000. When the bids were opened McDonough, Cunningham & Howland were disposed to feel that they had made a very serious mistake, and seriously considered the propriety of forfeiting the certified check which they had deposited with their bid as evidence of good faith. The author suggested, however, that before doing this they visit Indian Lake and look the ground over for themselves. On their return certain slight modifications of the contract were made, which had the effect of increasing their bid to about $92,000 instead of $85,278. The final estimate for the work, including the completion of the clearing and all other items, was $92,009. The profits on the work at this figure have not been large, probably from 10 to 12%.

In view of the peculiar circumstances of the letting, it was deemed desirable to keep much more careful force accounts than are ordinarily kept on such work, the said accounts including, so far as possible, expenses of every sort and kind. The following statement of the actual cost of the work has been compiled from force accounts so kept and from information furnished by the contractors:

Labor, not including clearing margins	$31,218
General expense	9,601
Raw material	18,830
Interest	1,150
Payments made or to be made, account clearing	13,000
Team work, delivery of cement and supplies	6,836
Insurance	1,235
Freight	960
Barn account, teams owned by contractor	725
Total amount	$83,555

The plant, which was purchased entirely new for this work, cost $10,343. Taking the depreciation at 33⅓%, or at $3,448, we have the value of the plant at the completion of the work of $6,895. The foregoing total of $83,555 includes in the general expenses the cost of placing the plant upon the work, as well as the estimated cost of returning it to Troy, N. Y.

In view of the exceedingly large bid of Messrs. McCagney & Linehan, Flood & Sherrill, and J. Whalen & Co., the author cannot but think that the outcome of this work is a very good illustration of the proposition that an ordinarily well-versed engineer, who has studied a piece of construction thoroughly, is likely to know about as nearly what the work will cost in actual construction as anybody, although in making this remark it must be pointed out that, considering the difficulties of doing work in a sparsely settled region, where supplies and material of every sort and kind must be hauled by wagon over mountain roads a distance of more than twenty miles, the margin of profit is not large enough. On comparing the original figures with the final results, it is clear to the author that the chief deficiency in the estimate was in not allowing enough for general expense. In that particular, at any rate, the author learned something from this work.

The foregoing details of the estimates, results of the letting and actual cost of the work, etc., have been gone into somewhat extensively because of the fixed opinion on the part of the author that it is from careful consideration of just such questions that one makes useful advances.

The Construction of the Dam.

By Wallace Greenalch, Jun. Am. Soc. C. E.

General Description.—The new Indian River dam is located about 150 ft. below the old wooden dam (Fig. 4), referred to by Mr. Rafter, the site being selected not only on account of the availability of the old dam as a coffer dam during the construction of the new dam, but further because the most economical profile was found at that point. Granitic rock, underlying several feet of boulders in the bed of the river and extending up the west bank within a few feet of the surface, forms the foundations of the main wall and gate house. An independent spillway is obtained by excavating the solid rock of the hill on the west side, as shown by the plan (Fig. 5) on the inset sheet. The east bank is composed of an impervious sand hardpan, a formation which is quite common in the glacial drift deposits of the Adirondacks. At the east end of the dam the bed rock in the river was found to extend for a considerable distance almost horizontally under the bank of glacial drift or hardpan, thus determining an earthen embankment with core wall as the natural form of construction on that side. The main dam wall, the wing wall, and the core wall are all joined together, as shown on the plans (Figs. 5 and 6), the core wall being carried well back on the rock into the impervious drift as shown.

Section.—The section of the main wall of the dam (Fig. 7) at its greatest height is 47 ft. high, 7 ft. wide on top and 33 ft. on the bottom; the width being gradually increased by batters on both faces as shown. The top of the coping is 7 ft. above the level of the spillway and the top of the embankment is 2 ft. higher.

Gate House and Discharge Tunnels.—To provide for the passage of water through the dam during construction, two discharge tunnels, 9 ft. in diameter, are built through the main wall at the west side of the river channel. The arch and invert rings are of selected rubble work, 20 ins. deep. Three buttresses, one on each side and one between the openings, compensate for the masonry taken from the section of the main wall by the discharge tunnels. The gate house is situated on the upper side of the dam, opposite the discharge tunnels, and consists of two wells 8 ft. square at the bottom and 12 × 14 ft. at the top, with side walls 8 ft. thick at the bottom, battering to 4 ft. at the top. The object of the two discharge tunnels was to take care of any large floods which might occur while the lower part of the dam was under construction, and thus prevent the water from flowing over newly laid masonry. For the permanent discharge from the reservoir, steel pipes, 5 ft. in diameter and 10 ft. long, were built in masonry inside the 9-ft. discharge tunnels. It was the original intention not to lay them in place until the main dam wall had been carried to a height above all danger from possible floods. The contractors, however, wished to lay the pipes as soon as the inverts of the tunnels were finished, and upon their agreeing to make good all damages which might be received from floods, they were allowed to do so. Fortunately no large floods occurred during the construction of the dam and the leakage and overflow from the old wooden dam was easily carried by the two 5-ft. openings. Single disk flume gates made by the Eddy Valve Co. are bolted to the pipes by flanged connections and regulate the discharge from the reservoir. Each gate-well is provided with two 3 × 5-ft. sluice openings, controlled by wooden slide gates and protected by steel gratings as shown. Owing to the difficulty of operating the slide gates on account of the excessive friction under full head of water, provision is made for filling the gate-wells by means of 6-in. pipes built through the walls of each well. A suitable superstructure with masonry side walls and shingle roof encloses the operating mechanisms of all the gates, as well as the apparatus for indicating the opening of the main gates. The maximum discharge through the two discharge pipes with full reservoir is estimated at 1,500 cu. ft. per sec., although it is not expected to discharge at a greater rate than about 1,000 cu. ft. per sec.

Logways.—Inasmuch as there is a large amount of valuable spruce timber still standing in the forests adjacent to Indian Lake and its tributaries, it became necessary to provide a logway for floating out the logs each spring. The main logway is 15 ft. in width, with the bottom 10 ft., below the spillway level, and is situated just west of the gate house. Heavy buttresses on each side carry the pressure of the water against the logway when closed, as well as form a gangway for the logs after passing the opening. The logway is controlled by means of 45 4 × 8-in. spruce timbers or "needles" about 20 ft. long, placed edgewise to the water in the reservoir. The needles are operated by a block and fall suspended from a gallows-frame above the needle-frame. For the purpose of floating out old snags or logs, when the water is at or above the level of the spillway, a subsidiary logway, with the bottom 18 ins. below the spillway level and controlled by three 6 × 12-in. timbers, has been provided at the east end of the spillway.

Spillway.—The spillway is located at the west end of the dam and is spanned by a foot bridge resting on five masonry piers. The effective spill is 106½ ft. long, and with the water up to the bottom of the floor stringers, about 6 ft. in depth, would allow a discharge of 5,000 cu. ft. per sec. With the large temporary storage of the reservoir it is not considered, however, that a discharge approximating 5,000 cu. ft. per sec. will ever take place. The spillway is 7 ft. wide in section with a downward slope of 18 ins. toward the back or upstream face. The top is coped with large selected stones firmly doweled to the masonry.

Embankment.—The embankment at the east end of the dam is 15 ft. wide on top, with a rip-rapped slope of 2½ to 1 on the upper or water slope and 2 to 1 on the lower slope. A rubble masonry core wall extends through the center of the embankment and into the hardpan from 8 to 20 ft. as shown. The trench for the core wall was made 4 ft. wide, with vertical sides, and then filled solid with rubble masonry. From the surface of the ground the wall batters to 2 ft. wide at the top. The embankment was deposited in 12-in. layers, sprinkled and thoroughly rolled with a two-ton roller. As no clay was to be found in the vicinity, some of the hardpan was deposited next to the core wall on the water side and thoroughly compacted by cutting and cross-cutting with spades. The object of this puddling was merely to insure an extra precaution against leakage from possible cracking of the core wall, as well as to prevent water from following along the surface of the masonry. Special care was taken in laying both the core wall and embankment to have them watertight. On the lower side of the dam, at the junction with the main wall, the embankment is held in place by a wing wall, but on the upper side, for the economical reasons stated by Mr. Rafter, the embankment is allowed to assume the 2½ to 1 slope until it rests against the main dam wall.

Mortar and Concrete.—The cement used in the work was required to meet the specification quoted by Mr. Rafter. It was delivered in barrels at North Creek by railroad and from thence hauled by wagon about twenty-two miles over a mountain road. All the cement used was tested on the work and found to be very satisfactory. The average of 455 neat briquettes broken was 530 lbs. per sq. in., while 1,342 briquettes of 3 to 1 mortar gave an average tensile strength of 169 lbs.

The sand was obtained from a bank on the shore of the lake about two miles from the dam and was transported to the work in a scow having a capacity of 30 cu. yds. per load. The scow was propelled by means of an anchor with a long rope and a windlass, after the ordinary method of moving lumbermen's rafts on lakes. Advantage was also taken of favorable winds by hoisting a large sail. In this manner a crew of six men and a foreman were able to deliver about 720 cu. yds. of sand and 180 cords of wood, for the steam boilers, per month, the wood being taken from points along the lake, in some cases several miles from the work. The sand obtained was of excellent quality, being almost entirely free from loam and exceedingly sharp. The mortar was composed of 3¼ parts of sand to 1 part of cement by volume, except for pointing and for bedding the lowest

course of masonry, where 2 to 1 mortar was used. The sand and cement were thoroughly mixed dry on a platform by means of hoes until the mixture acquired a uniform color. It was then mixed wet by passing through a mechanical mixer of the paddle type.

The proportions for making concrete were experimentally determined by measuring the voids in the broken stone to be used, and allowing a little more mortar than necessary to fill the voids. The proportions by volume of the dry materials were 1 part of cement, 3¼ parts of sand and 7⅛ parts of broken stone. This was found to yield an excellent concrete. In making the concrete, the sand and cement were first mixed dry as for mortar and then spread in a layer over the broken stone. The whole was then shoveled into the mixer where the water was supplied through jets, and all thoroughly mixed by the paddles in going through the mixer. The concrete dropped from the mixer directly into wheelbarrows or derrick boxes and thence was taken to the work.

Foundation and Masonry.—The surface rock in the river bed and on the west bank was quite seamy and disintegrated and was, therefore, removed by blasting until solid rock was reached. This was usually at a depth from 3 to 6 ft. below the surface. The rock thus found was remarkably free from any but fine closed seams and made an ideal foundation for the dam. A few small springs were found under the main wall, but were easily taken care of by building masonry wells around them in the following manner: About a foot or two in height was built at a time, so that as the well filled with water the pressure would not be sufficient to wash out the freshly laid mortar from the walls of the well. Successive courses of masonry were built up as the preceding courses became set, until the water from the spring had reached the level at which it would flow no more. The water was then bailed out and the well filled with rich concrete. The height to which the wells had to be built did not exceed 4 or 5 ft. Before laying any masonry great care was taken to remove all the rock which had been loosened by blasting and then to thoroughly clean the freshly exposed surface with a hose and brooms. The surface left by the removal of the loose rock was quite irregular, but to further insure against water following the foundation a layer of 3 or 4 ins. of 2 to 1 mortar was spread over the foundation, and the first course of masonry bedded in it. The rock excavated from the bywash channel and from the foundation, while solid, was found to break quite irregularly and could not therefore be used for the facing of the dam, though entirely suitable for backing. The facing was composed of large sized stone obtained from two quarries which were opened up within about 500 ft. of the east end of the dam. The stone—a syenitic granite—is of a pink color, fine grained and extremely durable, as was shown by the weathered outcrops of the quarry. It was found to be easily quarried into blocks, ready, with little or no work on them, to be laid into the dam. Considerable latitude was allowed in the joints of the facing, from 1¼ to 1½-in. joints being about the average obtained. The backing consisted of large irregular stones laid in full mortar beds about a foot apart, with the intermediate spaces filled with concrete thoroughly rammed to place. Stones of different sizes were purposely laid adjacent to each other, so as to avoid any regular coursing of the backing. The use of concrete in the above manner had the effect of considerably reducing the quantity of cement which would be required had the masonry been laid up in the ordinary manner by masons. No account was kept of the amount of cement used in pointing with 2 to 1 mortar, but an average of the whole work gives about 27% mortar.

The average cost per cubic yard of masonry laid during July and August, when the work was well under way and the conditions favorable, is as follows:

Quarrying face stone, average for month's work...	$0.35
Labor of laying masonry	.53
Labor of pointing	.15
Mixing mortar and concrete and crushing stone....	.20
Cost of cement	2.00
Cost of sand.	.15
General expenses, superintendence, etc.	.27
Total	$3.65

It was found impossible to reach anything like these figures except under the most favorable conditions.

The stone used for backing was paid for as excavation of rock, the cost of the labor of excavating the same during July and August amounting to 46 cts. per cu. yd.

The main wall is coped with concrete 12 ins. in thickness, laid in place on the dam in sections about 10 ft. long. Each section was allowed to set before the next was laid, thus making a transverse joint to allow for expansion and contraction.

The dam was constructed in about seven months, the work beginning in April and ending in October, 1898. With the exception of the cement, iron work, and contractors' supplies, which were transported by wagon from North Creek, this work was remarkable for the favorable conditions obtaining. Facing, backing, riprap, broken stone for concrete and lining, and earth for the embankment were all obtained immediately at the dam site. Sand and wood for fuel were delivered by boat directly at the work, both being obtained on the shore of the lake a few miles away. The timber and lumber, except the oak, which came by rail, were obtained at sawmills within three miles of the work. The use of the old dam as a coffer dam made "bailing and draining" a comparatively small item of expense.

In connection with the foregoing it may be noted that similar conditions are found at many of the dam sites examined and projected by Mr. Rafter for the water storage on the upper Hudson. Suitable materials for the construction of masonry dams are found at most of the sites, and it is one of the marked coincidences that at many of the sites a hardpan bank occurs on one side of the river valley resting on granite rock, which forms the bed of the river and extends up the other side.

The Clearing of the Timber Within the Flow Line of the Indian Lake Reservoir.

By Robert E. Horton.

Indian Lake was originally surrounded by heavy pine and spruce timber, reaching to the water's edge. In the original enlargement the flooded area was not cleared before submergence, but in undertaking the construction of the present masonry dam the plans included, as stated by Mr. Rafter, the clearing of the flooded area of all standing timber. This was done in deference to the views of people spending the summer in that vicinity, as a matter of pure æsthetics.

The total area of the new flowage is 1,160 acres. This area was mostly covered with hard and soft-wood timber—chiefly small spruce and balsam, birch and beech, ash, elm, maple and poplar. The soft wood, of commercial size, has long since been cut very closely from the lake margin, in consequence of which the larger trees were chiefly hard wood, which does not float, and which cannot, therefore, be rafted down stream to sawmills and converted into lumber. The problems presented in clearing this large area of timber, which was surrounded by very extended forests, were not only somewhat out of the usual line of ordinary engineering experience, but they must necessarily be repeated, in a large measure, in any future construction of reservoirs of considerable magnitude in the great water-gathering ground of the Adirondack region.

The contract price bid for cutting and burning was $15.00 per acre. As pointed out by Mr. Rafter, it was necessary for economic reasons that the work of clearing be done cheaply. This, as finally worked out, included in substance, (1) felling the trees; (2) the severing of the larger limbs from the trunks and trimming to such size as to admit of piling and burning; (3) the cutting of the trunks of the trees into suitable lengths either for piling and burning, or for sluicing through the logways provided in the dam; (4) the branches, underbrush and smaller trees to be in any case piled and burned. The method finally adopted for disposing of the larger trunks or bodies of the trees is substantially as follows: After cutting into proper lengths for burning the brush, etc., the large trunks are to be left until the reservoir is completed and filled, after which the hard wood and soft wood logs will separate, the former remaining at the bottom and out of the way, while the floating soft wood will be rafted down the lake and sluiced through the dam in the same manner as logs intended for lumber, after which it may be allowed to take care of itself as driftwood in the stream channel below. As to the propriety of throwing a large amount of driftwood into the channel, it may be pointed out that all such is caught at the big boom above Glens Falls and cut into firewood for the Glens Falls, Sandy Hill and Fort Edwards markets. As per specifications, the trees were cut at a height not exceeding 2 to 3 ft. above the ground. Cross-cut saws were used in the beginning for felling the trees, but the French Canadian woodsmen, by whom the labor was performed, prefer the axe, and its use soon became exclusive.

The operations of felling and trimming, and of piling and burning, were carried on separately, and as much time as possible allowed to elapse between the felling and burning in order that the timber might become seasoned. Burning could be successfully carried on only under the most favorable conditions of weather, that is to say, when it was sufficiently dry and the wind favorable. When unfavorable conditions prevailed the force employed on this part of the work was kept busy piling brush.

As to the advantage of leaving the fallen timber to season before burning, it may be remarked that for some kinds of timber it is of doubtful advantage, especially when one considers that labor can be saved if the trimming, piling and burning are done as fast as the timber is felled. Under this head it may be pointed out that spruce and balsam burn readily when freshly cut, and hard woods can be so burned if the brush is in closely compacted piles, especially if felled during the winter months when the sap is out, although heavy snow in the Indian Lake region may interfere at this season. Again, a portion of the Indian Lake flowage has been devastated by forest fires, and on such areas and in places where the original growth has been thinned by lumbering operations, we frequently find a vigorous second growth of poplar and paper birch. Both these woods burn readily when first cut, but if left lying on the ground soon become water-soaked, and in consequence exceedingly difficult to burn.

As stated by Mr. Rafter, certain practical difficulties arose in the operation of burning, such as the preventing of all injury to the adjacent forest, on which point the Forest Preserve Board was strongly insistent, the work being frequently inspected by Col. Wm. F. Fox, Superintendent of Forests, and carried on under the daily supervision of a State fire warden. The difficulties encountered under this head were at times quite serious, the fire frequently escaping into the forest, but happily without damage, except on two occasions. The difficulties of burning the brush and smaller trees might be classified as follows: First, on islands lying entirely below the level of the new flow line. These could be burned very easily and rapidly, as there was no danger of the fire spreading. The area thus classified is, however, comparatively small, aggregating not more than fifty acres; this was largely burned over in a single day. The second class included narrow, steep lake margins, and the shores of islands having summits above the new flow line, on which summits the timber was left standing. These narrow lake and island margins constituted the larger portion of the flowage, aggregating, roundly, 700 acres, distributed over a length of twenty-five miles, the average width of the cleared strip or margin being 250 ft., and having an average slope upward from the water's edge of about 1 in 10. For the narrower parts of the lake margin the slope was steeper in proportion, varying from almost perfectly flat areas to nearly vertical. It was found early in the work that the problem of burning the narrow margins was one of considerable difficulty. The open side toward the water gave free access to the landward winds from the lake, which, together with the natural tendency of the fire to creep up the slope, made it very difficult in places to prevent the fire entering the forest. However, it was found that, except under very favorable conditions, the fire, generally speaking, would smother out in the forest as soon as it ran beyond the reach of the lake breeze. Nevertheless, it was very desirable, since Indian

Lake is a pleasure resort during the summer, that the trees immediately bordering the new margin should be uninjured.

The difficulty of burning the margin varied greatly with the character of the timber. On soft wood areas the ground is often covered with spruce-duff to a depth sometimes of several feet. Fire once kindled in this is very tenacious, smouldering beneath the surface often for weeks, surviving even heavy showers, and when favored by dry weather and shoreward breezes, spreading into the forest and shooting up the inflammable spruces and balsams—the adjacent hard wood trees remaining meanwhile uninjured. To meet such cases it is necessary that all brush should be piled at least two rods from the standing timber and the intervening space cleared of duff and vegetable mould by means of grub hoes. Plowing, as called for by the specifications, or other common methods of forest fire prevention, were in many places inapplicable because of the presence of extensive areas of boulders and rough ground. Generally fire kindled near the new flow line would not run down the slope, but by first burning the brush adjacent to the standing timber, fires could afterward be started with safety near the water's edge, and it would then burn over the intermediate space, readily running up the slope.

At points along the margin, where hard wood timber chiefly prevailed, the danger from spreading fire was comparatively slight, although in order that the brush might be burned clean at the first firing, and not require additional labor of picking up and reburning, it was necessary that the brush be dry and closely compacted in the piles.

A third portion of the flowage consisted of heavily-timbered flat lands in the valleys, or bays, at the mouths of tributary streams. Chief among these we may mention Jessups River, in the valley of which an area of about 400 acres will be flooded, forming a lake several miles in length, and having an average width of slightly over one-eighth of a mile. This area was covered with a primeval forest of large trees, chiefly beech, black birch, swamp maple and water elm. So dense was the growth here, that after cutting and trimming the ground was covered with brush and logs to a depth of several feet. Inasmuch as this area is flat, and lies in a deep valley, unaffected by winds, burning by back-firing was successfully resorted to.

It is estimated that the timber within the new flow line, and which has been cleared as herein stated, would have made on an average from 50 to 75 cords of 4-ft. wood per acre, or a total for the whole 1,160 acres of something like 70,000 cords.

As to the disposition of the force employed on the clearing, it may be stated that this work was carried on by gangs of men of about twenty each, under one foreman. Laborers received $1 per day and their board, and foreman $35 per month and board. The average cost per acre of cutting, including some piling, but not the burning, was $7.50, and the rate of cutting averaged one-fifth acre per man per day. Owing to constant rains in October and November, 1898, about 300 acres of the burning is still incomplete, and hence the average cost per acre for this part of the work cannot be given at this time.

THE INFLUENCE OF THE SIZE OF TEST PIECE ON THE COMPRESSIVE STRENGTH OF CAST-IRON.

The third of the series of tests now being conducted by a special committee of the American Foundrymen's Association, to obtain accurate data from which to prepare a set of standard specifications for testing cast iron, was recently completed. Through the courtesy of the committee we are able to give, as in the two former cases (Eng. News, March 9, and April 20, 1899), the results of this test.

Cast "C," or the material for this test, consisted of 193 bars of "Light Machinery Iron," cast vertically, and at the same time in accordance with the specifications of the American Foundrymen's Association Committtee on standardizing the testing of cast iron. The set furnished 257 test pieces and 281 separate tests. It was supplied by the Westinghouse Electric & Mfg. Co., in the interest of the trade.

Cast "C" illustrates a class of castings which must be made with metal fluid enough to run into very thin sections, which must be soft enough to machine readily, and in which considerable transverse and tensile strength is essential. The composition in per cent., as taken from the one inch dry sand square bar, is as follows: Total carbon, 3.84; graphite, 3.52; silicon, 2.04; manganese, 0.39; phosphorus, 0.578; sulphur, 0.044. About 40% scrap is carried in the mixture.

The cross-section of the square and round bars was approximately equal for the relative sizes. The machined bars were turned or planed to the sizes given in the table, for the purpose of comparison. In the transverse tests the supports were all 12 ins. apart. The fresh fracture of each size of round and square, green sand and dry sand transverse bar, was preserved, and it is expected to be on exhibition at the coming convention of the American Foundrymen's Association, in Pittsburg, May 16-19.

From the fractures of the bars it is seen that the tendency to pipe is very strongly marked, the heaviest sections in some cases having fully developed pipes, the encircling walls being composed of white segregated (probably high phosphorus) material. All bars of the cast were serviceable and no tests were lost. The fluidity strips ran up full.

Compression Test of ½-in. Cubes of Light Machinery Iron. "Series C."

Approx. cross-section of test bar in ins.	Crushing strength in lbs. Middle ½-in.	First ¼-in. From edge.	Second ½-in.	Third ½-in.	Fourth ½-in.
½ × ½	38,500	.....	.....	.....	.....
1 × 1	24,890	27,900	.....	.....	.....
1½ × 1½	20,750	22,060	20,750	.....	.....
2 × 2	18,010	21,750	19,340	.....	.....
2½ × 2½	17,840	19,800	18,050	17,840	.....
3 × 3	15,950	18,170	16,850	16,040	.....
3½ × 3½	15,880	17,100	16,510	16,080	15,880
4 × 4	14,220	16,410	15,250	14,880	14,200

The cubes were cut from the square bars cast vertically in dry sand and were compressed along the length of the original bar. Test pieces were cut along a line at right angles to the sides of the bar. The value of the middle cube is repeated where it rounds out the series.

A STANDPIPE TEST was made at the Dun Building, New York city, on May 14, by Acting Chief Croker, of the New York Fire Department. The Dun Building is 225 ft. high, and is equipped with a 4-in. standpipe. The fire engine was connected to the standpipe at the sidewalk, and on the roof a short piece of hose was attached, a 1⅜-in. nozzle being used at the beginning of the test. The highest pressure reached was 50 lbs. at the nozzle with 210 lbs. at the engine. At this pressure the stream thrown reached the roofs of buildings 300 ft. away. A 1¼-in. nozzle was tried and the gage marked 60 lbs. pressure at the nozzle with 200 lbs. at the engine. The stream thrown, while it went about the same distance, was much steadier. The standpipe was then connected with hose on the sixth, twelfth and fourteenth floors, and four streams, including the one on the roof, were thrown from the building for about ten minutes. The two pumps in the building were then attached, and showed their ability to throw a stream almost the equal of the one from the engine, the pressure at the nozzle on the roof being only 5 lbs. less. The pressure shown in this test was considerably less than on the occasion of the tests on the Manhattan Building (Eng. News, April 20, 1899). The engine was not as powerful. The engine selected for each test is the one nearest the building, as being the first which would arrive in the case of a fire. Acting Chief Croker said at the conclusion of the test that it had shown that instead of being a source of danger to the business section, the extremely high buildings would be a great protection to the older ones if they were suitably provided with standpipes and connections for the apparatus of the department. The next test to be made will be at the Park Row Building, which is the tallest thus far erected. The test will be to throw good-sized streams from the two towers 358 ft. above the pavement. The building is now being piped, and the test is expected within a few weeks.

ELECTRIC CAB AND DELIVERY SERVICE on a large scale is proposed to be established in Chicago by the Illinois Electric Vehicle & Transportation Co. Mr. Samuel Insull, President of the Chicago Edison Co., is president of the new company, which is also said to be backed by the capitalists interested in the Electric Storage Battery Co., of Philadelphia. The cabs and delivery wagons will be operated by storage batteries, and their wheels will have solid rubber tires. It is said that the cabs are already being built. It is proposed to contract with the large stores to handle their delivery business. The vehicles will need to be substantially built to operate successfully in Chicago streets without excessive cost of maintenance and repairs.

THE COST OF UNDERGROUND RAILWAYS in London was given as follows in the course of evidence in an application to Parliament to build a new line of this character, the Baker St. & Waterloo Ry. All the lines are in circular, iron-lined tunnels, and operated, or to be operated, by electricity: Northwest London Ry. (not yet built), $2,425,000 per mile; Baker St. & Waterloo Ry. (projected), $2,875,000; Central London Ry. (under construction), $2,925,000; Great Northern & City Ry. (under construction), $3,265,000 per mile.

PROGRESS ON THE NEW WARSHIPS is reported as follows by Chief Naval Constructor Hichborn: The "Kearsarge" 90% completed; "Kentucky" 88% completed; "Illinois" 65% completed; all of these battleships are building at Newport News. At the Cramps yard the "Alabama" is 82% completed, and the "Maine" 4%. At the Union Iron Works, San Francisco, the "Wisconsin" is 67% done, and the "Ohio" has not yet been started. At Newport News the "Missouri" has just been started. At Armstrong's yard, in England, the sheathed cruiser "Albany" is 80% done. Work has been started on three of the four monitors authorized by the last Congress. The 16 torpedo boat destroyers lately authorized are commenced, with two of them 17% completed. Of the torpedo boats, two are 92 and 96% done, 12 others range from 6 to 75% done, and three are not yet started. The submarine torpedo boat "Plunger," at the Columbian Iron Works, Baltimore, shows 85% of work completed.

AMERICAN BICYCLES, to the value of $20,000,000, have been exported in the four fiscal years, 1896-'99. England and Germany lead in this consumption of American manufactures, though even Japan is a good buyer. In the fiscal year 1898 the values of bicycle exports were as follows: United Kingdom, $1,852,166; Germany, $1,724,404; Canada, $611,402; France, $482,682; British Australasia, $309,906; Netherlands, $251,918; Denmark, $228,370; British Africa, $148,503; British East Indies, $90,388; Japan, $88,905; China, $27,449; Dutch East Indies, $13,368; Africa, $11,647. The present year's sales to Japan exceed those of last year by 50%. These figures are given by the U. S. Bureau of Statistics.

CALIFORNIA REDWOOD, says Mr. Henry Gannet, in the "National Geographic Magazine,' covers an area of about 2,000 sq. miles, lying in a narrow strip along the Pacific coast, chiefly between San Francisco Bay and the Oregon boundary. The present "stand" of timber is roughly estimated at 75,150,000,000 ft. B. M.; and the annual cut is 250,000,000 ft. B. M. This tree is exempt from destruction by fire, as it contains no resin, but has in it much water, and will not burn when green. It is a cheap timber, worth $14 per thousand feet in Eureka for the best. A redwood forest is probably the densest forest on earth, both from the size of the trees and their closeness. The sun never shines about the base of these trees.

THE EARLY SMELTING OF IRON WITH COAL is set forth in an old book, entitled "Dud Dudley's Mettallum Martis; or, Iron made with Pit-Cole, Sea-Cole, etc." This book was printed in London in 1665; and it was reprinted in 1851, in England. The author, who was a relative of the Lord Dudley of that day, says that Charles I. granted him a patent for "the making of Iron, and Melting, Smelting, Extracting, Refining and Reducing all Mines and Metals with Pit-Cole, Sea-Cole, Peate and Turf, which (patent) was Extinct and Obstructed by Reason of the War." King James I. had previously granted a patent for a similar purpose to one Simon Sturtevant; he appears to have failed, and a new patent was granted to John Rovenson, who also failed. Dr. Jordeu, of Eath, and some others unnamed, being likewise unsuccessful, Dud Dudley obtained his patent and claims that he "Made Iron to Profit with Pit-Cole," at Pensnet, in Worcestershire. He says he sold "pigg or cast-iron made with pit-cole at four pounds per Tunn," and made "many tunns" in the 20th year of the reign of King James. At that time, he says, charcoal pig-iron was selling at from £6 to £7 per ton. The book contains many interesting details of the iron industry in England during the reigns of James I. and Charles I., the Commonwealth and Charles II.

THE CONTRACT FOR THE NEW ENTRANCE to New York harbor has been let to Mr. Andrew Onderdonk at 9 cts. per cu. yd. It is estimated that the dredging of this 40 ft. channel, 2,000 ft. wide, will require the removal of about 40,000,000 cu. yds. of material, all of which must be moved to deep water, an average distance of about 8 miles. The work must begin within a year of the signing of the contract, and be completed within 70 months. Suction dredges will probably be used. The Bay Ridge channel contract may be readvertised, as the lowest bid was 15 15-16 cts. per cu. yd., and this greatly exceeded the authorized amount. This channel would also be 40 ft. deep, but only 1,200 ft. wide; and the 20,000,000 cu. yds. involved would have to be transported an average distance of 21 miles.

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ADVERTISING RATES: 20 cents per line. Want notices, special rates, see page XIX. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

The excellent prospects for the early construction of the Long Island R. R. tunnel extension to lower Manhattan Island should prove gratifying news to those interested in the important question of improved transit facilities between business New York and the suburban residence districts of Long Island. Over ten years ago (March 17, 1888), Engineering News pointed out editorially the fact that nowhere within an equal distance of the New York City Hall was there the same area of moderate-priced suburban property available for residential purposes as on Long Island. At that time the means for getting to and from these residence districts by people doing business in New York were so entirely inadequate as to make them practically inaccessible. It is hardly necessary to say that conditions have improved in this respect in ten years, but even now transit facilities are woefully deficient as far as real suburban Long Island is concerned as distinguished from the outskirts of Brooklyn. As will be seen from the description of the new tunnel project given in another column, it is just these more distant suburban localities that the proposed tunnel route is intended to place within practical limits of time and convenience from Manhattan Island, not only for the permanent suburban resident, but also for the business man, who desires to spend the hot summer months with his family at some of the numerous seashore resorts, and yet be able to reach his New York place of business with reasonable convenience every day. That it will accomplish this much better than the present passenger traffic facilities between the same points is evident upon sight. In fact, it is not too much to anticipate that with fast tunnel trains meeting on schedule time each outgoing and incoming Long Island R. R. train it will be entirely within the limits of fast suburban train operation as conducted in other cities to bring these outlying towns actually nearer New York in point of time than Brooklyn itself now is.

The great disadvantage of the scheme as planned at present is obviously the necessity of changing from the electric tunnel trains to the steam trains at Flatbush Ave., although it is not easy to see how, under the present conditions, this can be entirely avoided. The running of steam locomotives through the tunnel is out of the question, as has been demonstrated by the experience of some of the older tunnel lines of London, where locomotives were used. On the other hand, it can hardly be hoped for some time yet that the Long Island R. R. will feel warranted in changing any great proportion of its present steam lines to electric lines. That such a change will partially take place as time goes on, however, we may, we think, confidently anticipate. Already the lines to Coney Island and the Rockaways are being equipped with electricity, and nothing will prevent the operation of through trains between these places and Manhattan as soon as the tunnel is completed. Such trains can, of course, be easily operated on a regular schedule, with the tunnel shuttle trains stopping at Flatbush Ave. In the course of time it is reasonable to assume also that the electric installation already begun will be extended to include other branch lines until a very considerable mileage of the western portion of the road which reaches the suburban towns and pleasure resorts nearest the city will be electrically operated. This, of course, enables the further extension of the through train schedule. That such a development of passenger traffic facilities will become an important factor in the progress of solving the problem of cheaply and comfortably housing the greater bulk, perhaps, of the population of Greater New York will, we think, be the conclusion of everyone who gives careful study to the subject.

The opening up of suburban Long Island to New Yorkers in search of permanent or temporary homes outside of the heat and noise of the city is, however, only one of the important benefits to be gained by the proposed improvement. For more than a score of years the city of Brooklyn has suffered in having one of its chief thoroughfares occupied for the greater part of its length by the double tracks of a steam railway line having a traffic often reaching 300 trains per day. The danger and inconvenience to the ordinary street traffic, and the injury to property values, which have resulted from these conditions, do not need to be enlarged upon to be appreciated, and they will be done away with to a very great extent by the new improvement. It is quite within belief to suppose that the appreciation in the value of real estate along Atlantic Ave. will by itself be great enough in a very short time more than to pay the city's share of the cost of removing the tracks from the street. This part of the improvement, like the tunnel proper, appeals favorably to the business judgment of anyone who studies it carefully. It is not proposed at this time to enter into the engineering features of the work further than has already been done in the article which appears in this issue, but a very little study will show that as a piece of construction the new tunnel will rank well up among the great tunnels of the world.

RIGHT OF WAY, GRADES AND GRADE CROSSINGS OF ELECTRIC RAILWAYS.

The development of electric railways for long lines and high speeds has introduced two questions of special interest: (1) The advisability of crossing steam railways at grade; (2) The construction of the line upon a purchased right of way instead of upon the public roads. Grade crossings of this kind have long been a source of trouble and danger, and many of the long interurban electric railways are built to some extent upon their own land, as in the case of the Chicago & Milwaukee Electric Ry., which was described in our issue of Aug. 25, 1898.

Our attention has lately been called to the interesting litigation over the proposed purchase of right of way for a portion of the new Aurora & Geneva Electric Ry., which involved both the questions above referred to, and also the question of maximum grades. Some particulars of the case will be of professional and public interest.

About two years ago, the Aurora & Geneva Ry. Co. (a New York company, organized in 1896) undertook to construct an electric railway from Aurora through Batavia to Geneva, Ill., a distance of about ten miles, including the lines within the two cities. The location, which was made by Mr. H. F. Dunham, M. Am. Soc. C. E., of New York, followed the line of the principal highway, known as Batavia Ave., from Aurora to within a short distance of Geneva. Here a deflection was made upon private property for a distance of about 1½ miles, in order to avoid a hill of full proportions and to avoid two railway grade crossings by means of subways. The accompanying cut shows the situation, the private right of way following the bank of the Fox River, which is 800 to 1,500 ft. east of the highway.

The road was built from Aurora to and through Batavia, without trouble; but as the company could not obtain all the land for the diversion from the property owners, steps were taken to condemn the land required. Some of the property owners, however, contested the right of the company to condemn property for street railway purposes to such an extent, under the provisions of the Horse and Dummy Railway Act of 1872* and 1874, although this act states that private property may be taken when necessary for the construction, maintenance and operation of the road, and for the sidings, sidetracks and appurtenances thereto, compensation to be made therefor under the Eminent Domain Act.† The property owners claimed that this power of condemnation is purely incidental, and while it might be exercised where necessary (1) to make the highway practicable, or (2) where some insurmountable obstacle necessitates a slight deflection from and return to the highway, or (3) where power houses, switches or turnouts demanded such use, that it could not be exercised to enable a street railway to cease to be a street railway, and (as in this case) to build its line on private property for 1½ miles. The company claimed that the power under this act is as broad as that under the acts relating to steam railways.

The case was tried in a lower court and decided in favor of the company, but a supersedeas was obtained from a Judge of the Supreme Court of Illinois, and later the question was taken to the Supreme Court. The opinion of the court stated that there is a wide and well understood difference between a railway organized for general traffic and a street (horse or dummy) railway, and that as the main object of the latter is to accommodate street travel, its cars must make frequent stops along the highway. It therefore has no use for private property, unless it might need a small track for a sidetrack, turnout or station, as an incident to its main line. The opinion contained the following quotation from the Supreme Court of Pennsylvania (Rehn Township vs. Street Railway, 167, Pa. St., p. 90).

> Street railways are railways on or along the streets of a city or town. They must conform to the grade of the streets they occupy. They may diverge for a short distance where the conformation of the surface or the positions of streams make it necessary in order to avoid discomfort or danger to the traveling public. But that a street railway may, like a steam railway, locate its route, not for the accommodation of local travel along the highways, but to reduce time and distance for passengers traveling from city to city or town to town across the country, is a proposition not to be entertained and involves a perversion of the character and object of street railways.

The court, perhaps, being unfamiliar with the development of railway transportation, failed to appreciate the distinction between a city street railway and an interburban railway or country tramway. An electric railway is not of necessity a street railway, as is shown by the extent to which such lines are built upon a purchased right of way in order to enable high speeds to be obtained, and in many cases the cars stop only at specified points along the line, these points corresponding to the stations of ordinary railways. The Aurora & Geneva Ry., however, is evidently a street railway, in that it is intended to follow the streets and highways for about 90% of its length, and to make a short diversion on the purchased right of way in order to obtain a safer route. The

*Revised Statutes, Chap. 66.
†Revised Statutes, Chap. 47.

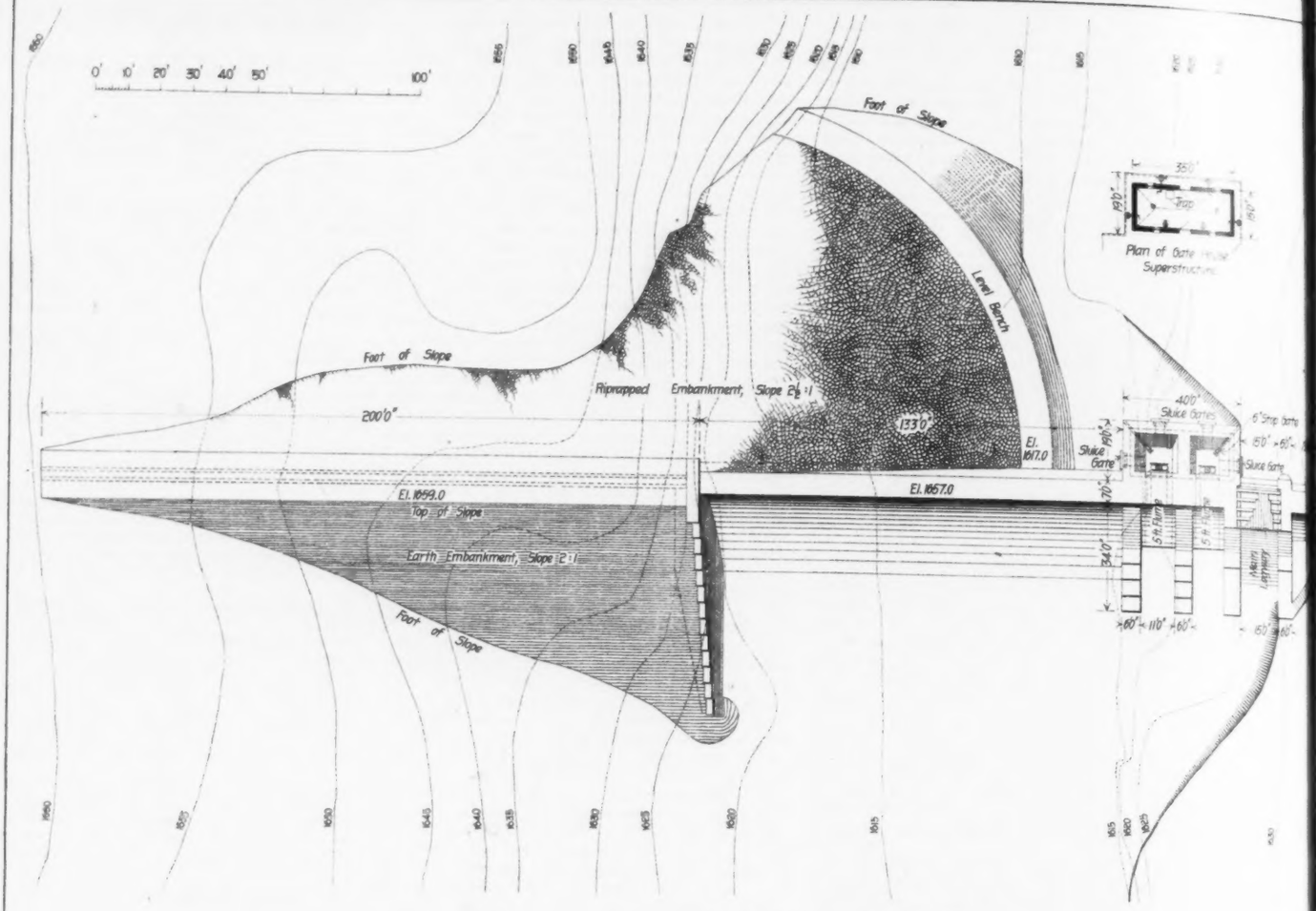
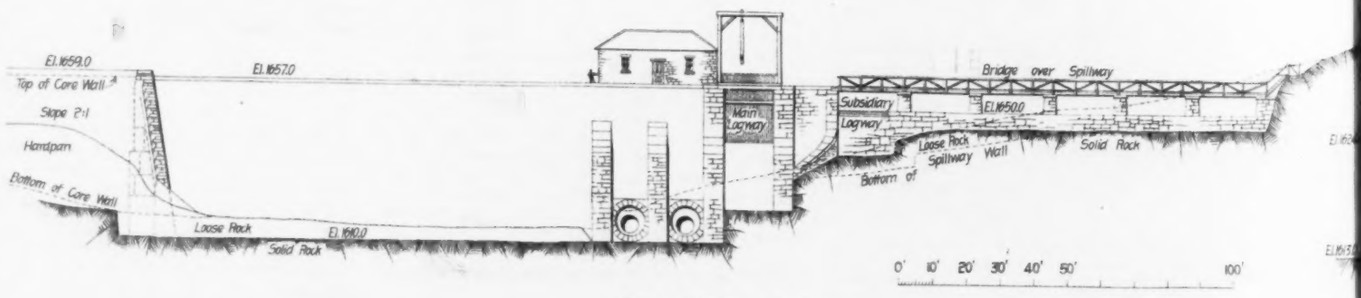
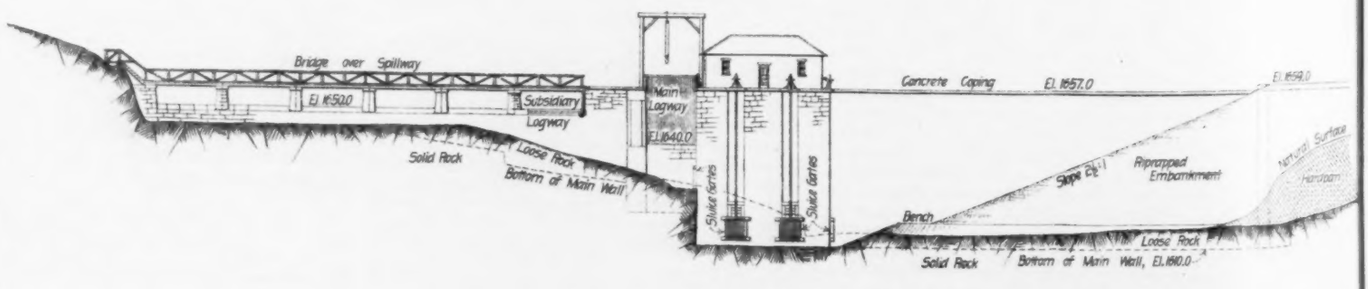


FIG. 5. PLAN OF DAM AND ACCESSORIES.



Down – Stream Elevation.



Up – Stream Elevation.

FIG. 6. FRONT AND REAR ELEVATIONS.

INDIAN RIVER DAM, HAMILTO

Campbell W. Adams, State Engineer and Surveyor; Geo. W. Rafter, M. Am. Soc. C. E., Engineer-inCha

McDonough, Cunningham & How

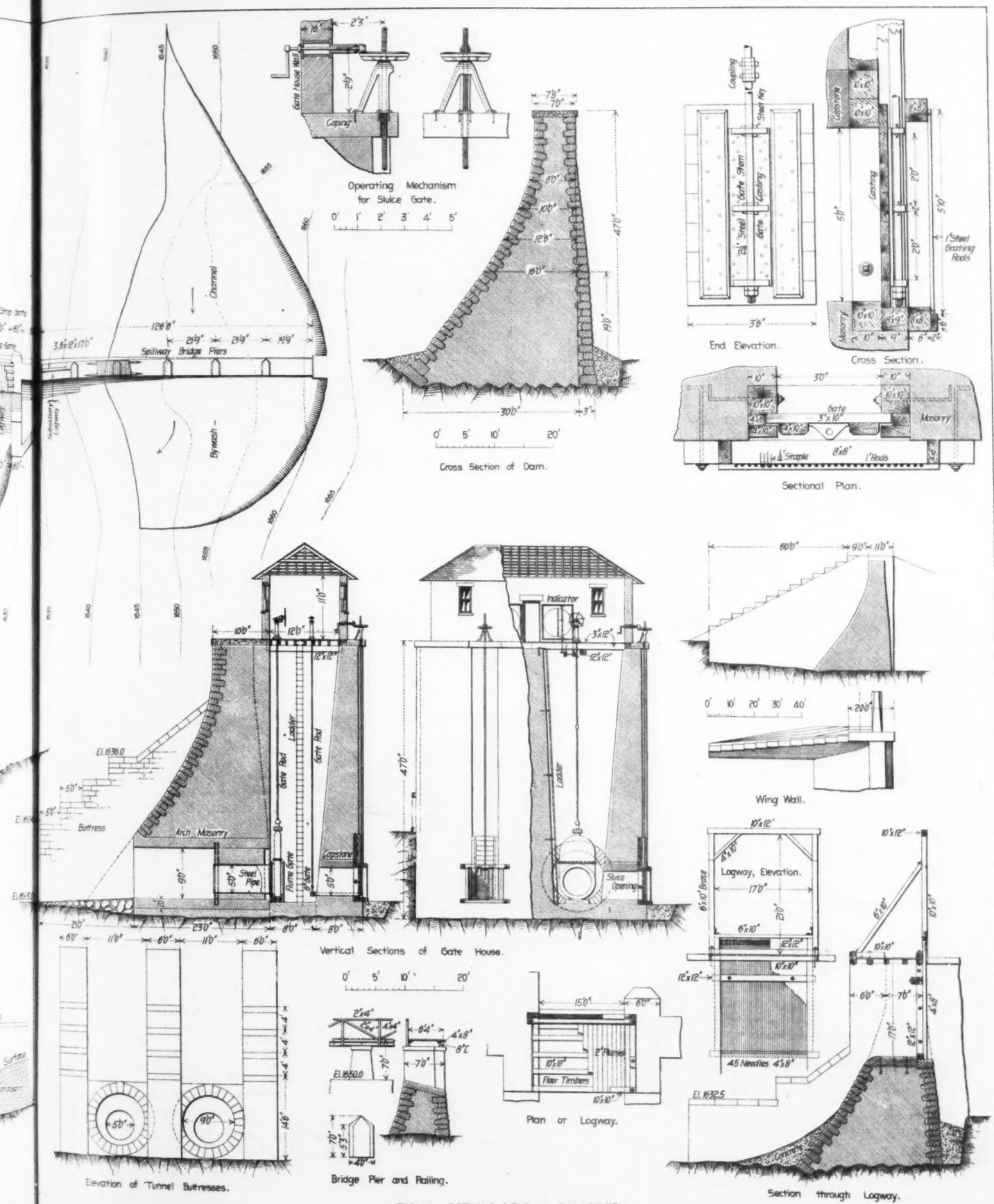


FIG. 7. DETAILS OF DAM, ENLARGED.

AM, HAMILTON COUNTY, N. Y.

Engineer-in-Charge; Wallace Greenalch, Jun. Am. Soc. C. E. and Robt. E. Horton, Assistant Engineers;

ningham & Howland, Contractors.

CHAS. HART, LITH., 96 VESEY ST., N. Y.

diversion is evidently in the interests of the public safety, as there is no physical reason why the railway could not follow the highway, crossing the C. & N. W. Ry. at grade and surmounting the hill above referred to. In fact, it was shown that the construction along the proposed diversion would increase the length of the line 1,600 ft., and would cost $25,000 more than if the highway was followed. The action of the New Hampshire legislature in passing a law permitting street railways to purchase land in order to enable them to avoid grade crossings we shall refer to further on.

The Supreme Court decided that no reason or necessity had been shown for leaving the highway and resorting to a right of way across private property. Under this decision (which is believed to be the first of its kind in the legal affairs of Illinois), it became necessary for the company to prove in court that obstacles of sufficient importance were in the line of the highway or street to warrant a deflection in the location. Hitherto, for plank roads, street railways, and all other cases in which it was necessary to exercise the right of eminent domain, that right had been assumed to rest with the management of the various corporations, the same as it does with a steam railway where condemnation proceedings are desired.

As already noted, the company's counsel had held in the first place that under the Horse and Dummy Act, the unlimited right to exercise the right of eminent domain existed as it does under Chapter 114 of the statutes relating to railway companies, and that, therefore, the company was not required to show necessity for the exercise of that right. The court, however, held that the power conferred under Section 2 of this act is not general, but that it is limited to a case when it becomes necessary to resort to private property, and that this necessity must be shown in the petition to condemn the land. It also held, however, that the company would have the right to exercise the power of eminent domain where "the conformation of surface or the position of streams make it necessary, in order to avoid discomfort or danger to the traveling public." The opinion also contained the following statements:

> If in the construction of the road in the highway, difficulties or obstructions were encountered which rendered it impracticable to construct the road in the highway, a necessity might arise, within the meaning of the law, which would authorize the company to leave the highway, and go upon private property, until the difficulty encountered was overcome, when a return could be made to the highway.
>
> In the construction of the road, if a necessity existed for making a deflection from the highway, in order to avoid a heavy grade which would prevent a successful operation of the road, the defendant in error (the railway company) would no doubt have the right to take and condemn private property to obviate the difficulty.

After this decision, the company proceeded to collect evidence as to the necessity for the adoption of the route crossing private property, and for the exercise of the right of eminent domain in regard to such property. Going back again to the lower court with the case, after the first Supreme Court decision, the company undertook to establish this necessity for the diversion of the line from the highway, bringing affidavits from some 25 or 30 civil and electrical engineers, including Mr. Geo. H. Benzenberg, City Engineer of Milwaukee; Mr. F. W. Cappelen, City Engineer of Minneapolis; and Mr. John Ericson, City Engineer of Chicago. To the company's surprise, however, the lower court decided flatly against it, contending that it had not established a right to acquire private property, as it desired. Then the matter was taken a second time to the Supreme Court. The final decision was handed down in February, 1899, and is wholly in favor of the company, so that the work which has been delayed for so long will now be at once taken up and pushed to completion. The decision is given at the end of this article.

The principal reasons given by the company as rendering it necessary to adopt this diversion from the highway were as follows:

(1) At a point just north of the commencement of this deflection, the Aurora branch of the Chicago & Northwestern Ry. crosses the highway with a grade of 68 ft. per mile, and on a curve of 4°, requiring a superelevation of 5 ins. for the outer rails. The topography is such that trains cannot be seen for any distance, and as trains pass at average intervals of 30 minutes from 6 a. m. to 8 p. m., the crossing is dangerous to persons traveling along the highway, and a grade crossing for the electric railway would be very dangerous.

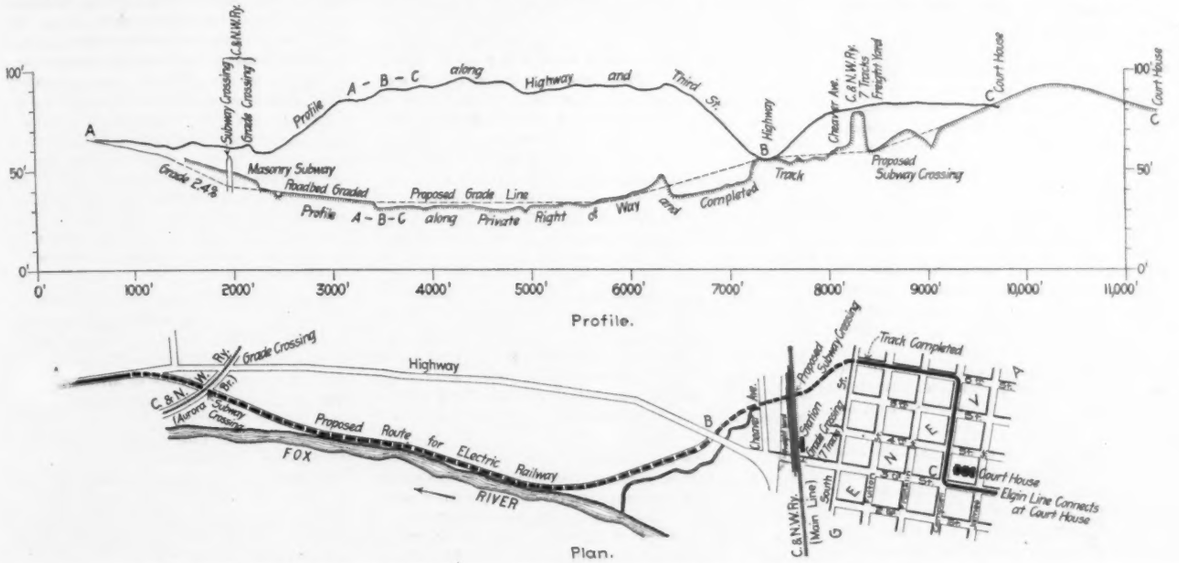
(2) North of the railway, the road ascends a hill over 40 ft. high by a grade of 4%, for a distance of 800 to 1,000 ft., and after reaching the crest of the hill descends a grade of over 5% for 800 or 1,000 ft., into a depression caused by a ravine crossing the road. From this it rises by a grade of 4% to 6% to the main line of the Chicago & Northwestern Ry. There are seven tracks at this point, and on week days, from 6 a. m. to 9 p. m., a train, engine or car crosses at average intervals of 10 or 15 minutes, as the tracks are used for making up and breaking up freight trains.

(3) The grades on the hill would be so steep that under bad conditions of the rails, the safety and lives of the passengers would be in danger, especially in view of the grade crossing at the foot of the hill. On the proposed diversion the grades would not exceed 2.2%, and there would be no grade crossing.

The claims for the property owners were as follows: (1) That neither of these crossings was "impossible, impracticable or dangerous," but perfectly practicable, and (with the use of reasonable and ordinary precautions) not at all dangerous; (2) that the electric road could, if necessary, pass under the C. & N. W. Ry. at both points by means of short deviations from the highway; (3) that any grade not exceeding 7% constitutes no material difficulty in the operation of an electric railway, and no necessity for deviation from the highway, even when such grade is distant nine miles or more from the power house, while on the line in question the grade need not exceed 4%.

It is interesting to note that the counsel for the property owners opened their argument before the Supreme Court (December term, 1898), by quoting the motto adopted for the locating engineer in Wellington's "Economic Theory of Railway Location," as follows: "The words of Alexander as he stood before the Gordion knot, 'Aut viam inveniam aut faciam,' seem to have been adopted by the appellants (the railway company) in this cause as their principle of action." The argument then proceeds to refer to the "impatient, wilful, determined arrogance and greed" of the company in its efforts to take the lands and houses of the appellees (the property owners). This sort of declamation, however, though somewhat popular in legal circles, means nothing, and has probably very little influence upon the judges who have to listen to it. It certainly seems that, as the company's engineer could not "find" a good route, he proceeded to "make" one, but that efforts were made to compel the adoption of the inferior route, regardless of the fact that it would have seriously endangered the public safety.

In regard to the effect of the line upon the property it was desired to cross, the usual claims of detrimental effect were made, and appear to have been much exaggerated, as is usually the case. The evidence given in opposition to the diversion was largely as to the practicability of operating electric railways on steep grades, and as to the possibility of effectively protecting the grade crossings by interlocking plants and the adoption of rules and regulations. Evidence was also presented to show that subway crossings could be provided by short diversions at each point without the necessity of the long diversion, and that the grades (though not in themselves objectionable) could be reduced by small expense. The company, however, showed that the short diversions would involve awkward alinement, with steep grades and sharp curves which would be an element of danger, especially as some of these combinations would occur close to the subways. It also showed that the change of grades along the highway would affect and injure other property owners. Much of the evidence was quite irrelevant, as the mere operation of electric railways on grades of 4% to 7% has little bearing upon the case in question, where a grade crossing (with heavy traffic)



PLAN AND PROFILES OF THE GENEVA END OF THE AURORA & GENEVA ELECTRIC RY.

at the foot of a steep grade constituted a specially dangerous feature.

In view of the important bearing of this case upon the construction and operation of long distance electric railways, it will be of interest to consider some of the engineering evidence, as presented in the affidavits accompanying the records of the case, showing the arguments made for and against the questions of route, grade and grade crossings.

Mr. James R. Chapman, formerly of the Grand Rapids electric railways, stated that "grades of 5% are of very frequent occurrence in electric railway practice, and are regarded as of no practical consequence," while a grade of 7% would constitute no severe obstacle. Mr. G. S. Johnson, General Manager of the Grand Rapids lines, instanced grades of 5 to 10% in that city, but it was shown that these were formerly operated by cable, and that when electric traction was substituted it was found that the cars would slide down the grades in spite of the current and the ordinary brakes. Mr. Chapman, therefore, devised a wedge brake, working in the old cable slot, in spite of which a car ran away and collided with another car.

Mr. J. I. Beggs instanced grades of over 8% in Milwaukee, Wis., and of 10 to 12% in Cincinnati, O., and Albany, N. Y. Mr. D. S. Smith, Superintendent of the St. Paul City Ry., referred to grades of 5 and 6%, 300 to 1,000 ft. long, one 6% grade being 24 miles from the power house.

Mr. W. S. Gamble stated that the Elgin City Ry. has a 7% grade, 1,100 ft. long, and a 6% grade, 500 ft. long, while the Elgin, Carpentersville & Aurora Ry. has a 5% grade, 1,850 ft. long, and others of 4 and 4½%. A resident of Elgin, however, stated that on a misty evening in October, 1897, he was a passenger on a car of the Elgin City Ry. which got beyond control in descending one of these grades. The car ran down at high speed to the grade crossing of the Chicago & Northwestern Ry., and was run into by a train, the witness and his wife being seriously injured.

Mr. Robert Gilham, M. Am. Soc. C. E., referred to the Kansas City Elevated Ry. (formerly part cable and part dummy), which is operated on the trolley system, and has a grade of 9% for 1,000 ft., while the Northeast Electric Ry. (a surface line) has short grades of 10%, largely at street corners, as the road changes its direction. Mr. L. W. Rundlett, M. Am. Soc. C. E., City Engineer of St. Paul, gave the same evidence as Mr. D. S. Smith, and also stated that in 1897 he investigated the question of the safe and successful operation of electric cars by trolley on a grade of 10 or 12%, and learned that such grades are in operation in various cities.* No reference was made, however, to the use of auxiliary systems of traction on such steep grades in order to increase the facility and safety of operation. We may remind our readers that a commission of engineers was appointed to consider the feasibility of operating electric cars on Selby Ave., in St. Paul, with grades of 9 and 16%. The report stated that it would be safe and practicable, but would require some auxiliary system, and that probably the use of cable or rack-rail traction would ultimately furnish a satisfactory solution of the problem (Eng. News, March 25, 1897). We learn from Mr. Rundlett that the auxiliary system eventually adopted was the cable and counterweight system, somewhat improved upon that in use at Providence, R. I., and that it has been working very successfully.

Mr. F. W. Cappelen, M. Am. Soc. C. E., City Engineer of Minneapolis, stated that in the reconstruction of the tracks of the electric railways, no grades of over 4% have been used, and that both the city and the street railway company were taking steps to reduce these in the interests of public safety. He had known cars to leave the track on such a grade. Mr. John Ericson, City Engineer of Chicago, said that as to the grades of 3% and 4% on the Chicago viaducts and bridge approaches, they are short, and not attended with the dangers incident to the line at Geneva. Nevertheless, they are only permitted because there is no way of avoiding them. Mr. Wm. A. Lynch, President and Manager of the Canton and Massillon city and interurban system of electric railways, stated that 5% grades are operated on these lines, but that their use is dangerous, especially under certain conditions of the track. Such a grade is in itself a very objectionable part of an electric railway, and while cars often slide without causing any accident, yet such sliding is always liable to produce serious results.

Some of the engineers considered 3% grades as the maximum allowable for safe and economical operation under ordinary conditions, and stated that while grades of 5 and 6%, or even more, are actually used, yet they are attended with danger, and should always be avoided where it is practicable to do so. In fact, Mr. H. F. Dunham, M. Am. Soc. C. E., the locating engineer of the company, stated that he had visited the steep grade lines in St. Paul, Milwaukee and Toledo, and had found that in each case barrels or boxes of sand were placed at intervals of a few hundred feet in order to provide means for lessening the danger from the wheels sliding upon the rails. From this it appeared that the dangers of operation on these grades were evidently recognized. It was also shown that at Geneva, along the highway (on the hill) there is heavy foliage, and that at certain times of the year the leaves falling upon the track would form an impediment, making the tracks so slippery that ascending cars might be stalled and descending cars might get beyond control. Then, too, the character of the macadam of the road is such that the mud would also make the rails slippery. On a suburban line, with cars running at infrequent intervals, the rails may easily become foul with leaves, mud, moisture, frost or snow.

In regard to the grade crossings of steam and electric railways, most of the affidavits presented in the case for the property owners admitted that they are undesirable, and should be avoided as far as possible, but stated that they are of frequent occurrence, and not so dangerous as to make the avoidance of them a practical necessity. Mr. Gilham, however, further stated that they call for additional watchfulness and care, largely in proportion to the number of trains on the steam road. Mr. W. F. Carr, M. Am. Soc. C. E., did not consider that a grade crossing of the Aurora branch would have an "element of danger worthy of serious consideration," if operated under ordinary rules regarding the stopping of cars at such points, while by the use of the interlocking system "this or any other grade crossing can be made absolutely safe." He also considered that a subway would cause serious trouble and expense during the winter, but gave no instance of such experience on any subway crossings now in use. It seems to us that any engineer should consider a grade crossing on a steep grade and a sharp curve as worthy of the most serious consideration, and the most serious attempts to avoid it. Mr. Carr stated that a crossing of standard construction (with flangeways for both lines), or of the "jump" type (in which the rails of the street railway are elevated to permit the wheels of the cars to jump across the rails of the steam railway), could be operated safely. It was pointed out, however, that the latter form is a very poor method of construction, tending to aggravate the liability to derailment.

At both crossings there would be exceptional liability of the car leaving the rails, or the trolley jumping off the wire; (1) at the crossing of the Aurora branch, the 5-in. elevation of the rails, together with the curve and grade of the steam railway, would make a rough and awkward crossing, which would be expensive to maintain; (2) the number of frogs at the crossing of the main line would also make a rough track, which, with the necessary increase in the elevation of the trolley wire (at both crossings), would tend to cause the trolley to become displaced. Mr. Lynch explained that it would be possible to put in an interlocking device to prevent the electric car from reaching the crossing unless and until some one had first gone upon or across the steam railway, and there operated the device so as to permit the car to pass. This plan was frequently used, but it would not render the crossing absolutely safe. A car is always liable to have its supply of current instantaneously interrupted, and this danger is increased where the crossing includes a number of tracks. The grade crossing of the main line would not only be dangerous in itself, but the use of an interlocking plant would involve serious inconvenience to the C. & N. W. Ry. in the operation of its traffic and its switching movements.

Mr. Ericson thought the railway ought to be compelled to build its line on the proposed route, on account of the greater safety for the traveling public. The highway was too impracticable a route to be seriously considered (so far as the rights and safety of the public are concerned), while the dangers of the grade crossings were such that, in his opinion, it would be criminal carelessness to permit of their construction. Mr. Cappelen stated that in Minneapolis grade crossings were considered exceedingly dangerous, so much so that more than 50 had been abolished, while in consequence of accidents at such crossings, preparations were being made to abolish those remaining. Attention was drawn to the fact that the tendency of public opinion, and the practice in many cities, is toward the abolition of grade crossings, and Mr. Cappelen considered that no grade crossing of a steam railway and an electric railway should be built if it could possibly be avoided. No safety appliances can make such a crossing absolutely safe.

In regard to the use of interlocking plants for the protection of the crossings, evidence was presented from Mr. E. D. Wileman, Assoc. M. Am. Soc. C. E., of the Signal and Interlocking Department of the Lake Shore & Michigan Southern Ry. He stated that a grade crossing of a steam railway and an electric railway is more dangerous than one where two steam railways cross, as in the former case the steam road claims the right of way, and the movement of cars on electric roads is liable to derangement without notice or apparent cause. A grade of 68 ft. per mile on a 4° curve, on a steam railway (as at the Aurora branch), would make a grade crossing more than usually difficult and dangerous. To afford safety in any considerable degree it would be necessary to provide derailing switches in the tracks of both roads, but this—at the main line crossing at Geneva—would require the abandonment of the freight yards, as under the Illinois law the derails must be at least 150 ft. on each side of the crossing. This would prohibit the use of derails on the C. & N. W. Ry. tracks, and without them a grade crossing would be decidedly dangerous. Mr. James G. White, of J. G. White & Co., engineers and contractors, New York, stated that on the Buffalo & Niagara Falls Ry. an expenditure of $30,000 was made solely to avoid the danger of a grade crossing, while on the Atlantic Highlands, Red Bank & Long Branch Electric Ry., two steel viaducts were built at a cost of about $40,000 to avoid dangers incident to grade crossings.

The company introduced evidence as to accidents on electric railways, in the course of which it was shown that in December, 1897, the General Manager of the Boston & Maine R. R. testified before the Railroad Commissioners of New Hampshire, that his company had a record of several hundred cases of loss of power by electric cars while passing over grade crossings. The Commissioners considered it necessary, therefore, to deny any petitions for such crossings. As a result of this evidence, the State Legislature of New Hampshire passed a law in 1898 providing that a street railway may purchase land for a right of way 50 ft. wide in order to avoid or eliminate a grade crossing.

It is somewhat curious to note, too, that during the time the construction of the Geneva line was under consideration, Mr. W. H. Pease, County Surveyor of Kane Co., Ill., was run down by a train and killed while driving over the road crossing of the Aurora branch. From the evidence in the case in question, and from the accident rec-

*Stillwater, Minn., 9.85%, 300 ft. long; 9%, 318 ft.; 8.81%, 300 ft.
Sioux City, Ia., 11% and 9%, 300 ft. long.
Methuen, Mass., 10.25% for a short distance.
Lawrence, Mass., 7%, 400 ft.
North Andover, Mass., 7 to 9%, 300 ft.
Tacoma, Wash., 12%, 100 ft.; 10%, 300 ft.
Dubuque, Ia., 9 to 10%, 800 to 1,000 ft.
Allegheny, Pa., 9½%, 1,000 ft.; 10%, 1,800 ft.
Cincinnati, O., 8 to 9%, half a mile.
Peoria, Ill., over 8%.
Duluth, Minn., 8 to 9%, several hundred feet.
Haverhill, Mass., 7 to 8%, 400 ft. and 290 ft.

ords of Engineering News during the past three years, we have compiled a list (which is certainly incomplete) of about 30 accidents caused by electric cars running away.* These accidents resulted in about 40 deaths and the injury of nearly 300 persons.

In the final opinion of the Supreme Court of Illinois, which has already been referred to, the court held that in the construction of the statutes relating to the taking of private property, the word "necessary" should be construed to mean "expedient," "reasonably convenient" or "useful to the public," and cannot be limited to an absolute physical necessity, as had been claimed by the counsel for the property owners. It also showed that the general physical conditions were admitted by both parties, and that five of the twelve witnesses for the property owners admitted that grade crossings are always undesirable and ought to be avoided if possible, while two or three of the witnesses stated "in a general way" that such crossings can be made safe by a system of interlocking switches. The opinion quoted the affidavit of Mr. Lynch, for the railway company, which has been already referred to, and stated that the statements made therein were fully and repeatedly corroborated in the affidavits of the other 26 witnesses for the railway company. The court agreed to the legal ground of the claim made by counsel for the property owners, to the effect that even if the departure from the highway is necessary, a return thereto can be made immediately, but held that the facts in the case showed that such a return was impracticable. The actual opinion was as follows:

From the facts stated, and the opinions given by all the witnesses, it is impossible to escape the conclusion that by the clear preponderance of the evidence, such a necessity for the condemnation of private property by street railway companies as is contemplated by the statute, has been established by the petitioner (the railway company) in this case.

We are of opinion, that under the evidence in this case, the petitioner established its right, under the law, to condemn the property sought to be taken, and that the circuit court erred in its judgment denying it that relief. Judgment will accordingly be reversed, and the case will be remanded, with directions to proceed in conformity with the views herein expressed.

It will be seen from the extracts which we have given, that, on the whole, the engineering evidence was overwhelmingly in favor of the route proposed by the company, although the counsel for the property owners tried to beguile the court with a fairy story to the effect that the engineers would naturally try to help a brother engineer. Leaving out of the question all matters except the grade crossings, it certainly appears that the conditions were such that it should not have been possible for the railway company to obtain authority to construct them, even if it had so desired. The case was one of great importance in its relation to the development of electric railways, and the abolition of grade crossings, and it is fortunate that the decision of the court has sustained the position taken by the company.

*Accidents caused by electric cars running away on grades (except the one at Chicago, which was on the level:

		Killed.	Injured.
.... .., 1890.	St. Joseph, Mo.*	..	..
Sept. 18, 1891.	Dubuque, Ia.*	..	..
Aug. 11, 1892.	Lawrence, Mass.	2	66
Jan. 2, 1895.	Marshalltown, Ia.*	..	1
Dec. 30, 1895.	Philadelphia, Pa.*†	..	..
Feb. 7, 1896.	Rankin, Pa.*†	1	..
May 28, 1896.	Brooklyn, N. Y.†.....	..	5
June 7, 1896.		1	20
July 19, 1896.		..	7
Aug. 9, 1896.	Columbia, Pa.†	6	60
Aug. 22, 1896.	Brooklyn, N. Y.†.....	..	4
Aug. 23, 1896.	Frederick, Md.†.....	..	35
Sept. 3, 1896.	St. Paul Minn.*	..	7
Sept. 4, 1896.	St. Paul, Minn.	..	2
Nov. 20, 1896.	Leavenworth, Kan.* ...	..	2
Jan. .., 1897.	Leavenworth, Kan.* ...	..	1
Jan. 9, 1897.	Minneapolis, Minn.* ...	1	6
Jan. 14, 1897.	Pittsburg, Pa.†	..	6
Feb. 3, 1897.	Abington, Mass.†	1	1
Feb. 25, 1897.	Chicago, Ill.*†	3	2
April 9, 1897.	Allegheny, Pa.*†	..	1
April 27, 1897.	Portland, Ore.†	3	..
July 5, 1897.	Haverhill, Mass.	..	Several.
Oct. .., 1897.	Elgin, Ill.*	..	2
Nov. 15, 1897.	Forest Home, Ill.*.....	..	1
Dec. 4, 1897.	Detroit, Mich.†	3	20
July 10, 1898.	Washington, D. C.†....	1	30
Sept. 5, 1898.	Cohoes, N. Y.*†.....	18	12
Sept. 5, 1898.	Washington, D. C.*.....	2	..

*Runaway and collision at grade crossings.
†See Engineering News of about the same date.

LETTERS TO THE EDITOR.

The Explosion of the Bunker Hill & Sullivan Mining & Concentrating Plant by Rioters.

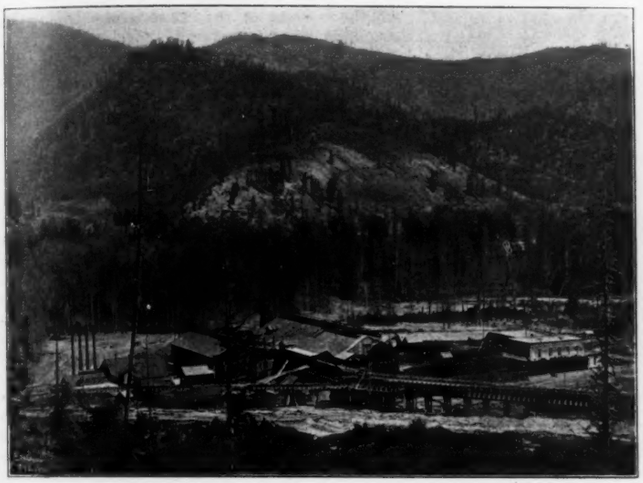
Sir: Under separate cover I send you two pictures of the Bunker Hill & Sullivan Mining & Concentrating Co.'s plant at Kellogg, Idaho. One of these shows the plant before the explosion, and the other shows the plant shortly after the explosion of 3,000 lbs. of dynamite. On April 29, 1899, the combined union force of the Coeur d'Alene Mining Country, numbering about 1,000 miners, assembled at Kellogg for the express purpose of destroying the Bunker Hill property, consisting of mill and power plant. The mill is a lead-silver concentrator, capable of concentrating from 700 to 800 tons of ore per day. The power plant was a large two-stage compressor, capable of compressing 3,000 cu. ft. of air per minute to 90 lbs., together with electric light and power machinery. Compressed air was conveyed to the mine, situated some 10,000 ft. away, through a steel pipe laid over the mountain from the plant to the mine.

The picture shows very distinctly a portion of the compressor wheel and bed plates of the compressor on foundation, together with the four boilers that supplied steam for the plant. The concentrator is shown in the background. The country at the present time is under martial law, and some 800 or 900 of the dynamiters are in prison here. What the outcome will be is as yet unknown. The country is wild with excitement. The Bunker Hill & Sullivan Co. has commenced to clear the ground to rebuild the plant. A large part of the lumber for the new buildings is already on the ground. I enclose two clippings from the "Spokesman Review," of Spokane, Washington, one giving the number of men locked out and the other giving the output of the various mines, which is very nearly correct.

Very truly yours,
Ulysses B. Hough,
Engineer for the Bunker Hill & Sullivan Mining & Concentrating Co.

Kellogg, Idaho, May 9, 1899.

(According to the clippings to which our correspondent refers, the suspension of work in the various mines of the Coeur d'Alene territory, as the result of the lawlessness of the miners, throws over 1,500 men out of work. Of these 450 men were employed by the company, whose wrecked plant is shown in the accompanying engravings. The output of the mines which have closed down amounted last year to about 111,000 tons of ore and concentrates, valued at over $6,000,000. It was estimated early in the year that this output would be increased 50% during the present year. —Ed.)



VIEWS OF THE BUNKER HILL & SULLIVAN MINING & CONCENTRATING CO.'S PLANT BEFORE AND AFTER ITS DESTRUCTION BY A DYNAMITE EXPLOSION.

THE BROOKLYN TERMINAL IMPROVEMENTS AND EAST RIVER TUNNEL OF THE LONG ISLAND R. R.

Introduction.

One of the most comprehensive and costly railway terminal schemes now projected anywhere in the United States, is that which the Long Island R. R. Co. has under way to provide an all-rail route for high-speed service from the suburban towns of Long Island direct to the business centers of Brooklyn and Manhattan Island. This railway now has three terminals at the western end of Long Island. Two of these are primarily freight terminals, and are located at Long Island City and Bay Ridge, and the third is the main passenger terminal, located at the intersection of Atlantic and Flatbush avenues in Brooklyn. Both of the freight terminals have become crowded for room to the point of serious inconvenience, and the passenger terminal suffers under the disadvantage of being located at a point of comparatively little convenience to either the residential or business districts of the two cities. The projected improvements include the betterment of the freight terminals and the lines leading to them, an extension of the passenger terminal to Manhattan Island, the building of a general distributing yard at Jamaica, and various subordinate improvements. The map, Fig. 1, shows the location of the various points named, and also of some of the improvements, which will be described later.

History.

To understand clearly the significance of the proposed improvements, a brief sketch of the conditions which have led up to them will be of value. Among the earliest railway enterprises of the United States was the Long Island R. R., projected with the idea of making a quick connection between New York and Boston by means of a railway reaching from South Ferry in Brooklyn to Greenport, Long Island, and thence by steamboat to Newport, R. I., where connection would be made with the railway lines throughout New Eng-

land. For the purpose of constructing the portion of the line on Long Island, two companies were formed; the Brooklyn & Jamaica R. R. Co., building from South Ferry to Jamaica, and the Long Island R. R. Co., building the remainder of the line to Greenport. The work of construction covered the years 1834 to 1836.

During the succeeding 20 years Brooklyn grew from a small village clustered around the Fulton Ferry to a city of considerable size and population, and a street was laid out along the line of railway from the ferry to Classon Ave. This street was named Atlantic St., and was within a few years extended to East New York. The occupancy of this prominent thoroughfare by a railway of such trifling importance was quickly found to be a nuisance far beyond the benefits gained, and in response to the demands of public opinion the railway company was induced to abandon operation by steam power within the limits of the city and to establish its terminus at Hunter's Point (Long Island City). To reimburse the railway company for the curtailment of its franchise and for the expense of removal the property along the old line was assessed upon. The company retained its right to operate horse cars along the avenue and continued to do this until 1876. Meantime, by successive reorganizations, the original Brooklyn & Jamaica R. R. Co. had become the Atlantic Avenue R. R. Co. The original Long Island R. R. Co. had also, by means of a series of consolidations and by the construction of many branches and extensions, grown to a railway system of importance, operating all the steam roads on Long Island.

The need of a Brooklyn terminus for this system was a pressing one, and the Common Council of the city, by authority of an act of the State Legislature, finally solved the problem by restoring to the Atlantic Avenue R. R. Co. the right to operate by steam power east of Flatbush Ave., and the Long Island R. R. was thereby enabled to secure a terminus at Flatbush Ave., by lease of the Atlantic Ave. R. R. It is not essential to carry history further at the present time, but it remains to be noted that from shortly after the date of the lease just mentioned, March 26, 1877, the Long Island R. R. tracks have occupied the center of Atlantic Ave. from Flatbush Ave., east its whole length. The objection to this location was not so great at first, but as time went on and the city grew, the road, notwithstanding that it was fenced in and guarded by gates at all street crossings, has become a serious nuisance. There has been much litigation at one time and another between the railway and the city as a result of the efforts of the latter to get the railway tracks off the surface of Atlantic Ave., but no very promising results were secured until a commission was appointed by the Mayor of Brooklyn, under the authority of the State Legislature, "to examine and report upon a plan for the improvement and relief of Atlantic Ave. in the city of Brooklyn." This commisson met with hearty cooperation from the Long Island R. R. Co. and reported, with a complete plan for removing the surface steam railway tracks on Atlantic Ave., early in 1897. (Eng. News, Jan. 14, 1897.) The report met with general favor from the public and steps were at once taken to get the scheme on a basis upon which to begin actual construction.

FIG. 1.—MAP OF WESTERN END OF LONG ISLAND AND LOWER MANHATTAN ISLAND, SHOWING LOCATION OF PROPOSED LONG ISLAND R. R. TERMINAL IMPROVEMENTS.

Preparatory Legislation.

A bill providing for the removal of the tracks of the Long Island R. R., from Atlantic Ave., in the city of Brooklyn, was introduced in the Legislature in 1897, and became a law by the signature of the Governor on May 18, 1897. Under its provisions a board of seven members was to be appointed by the Mayor of Brooklyn, whose duty it should be to carry the law into effect. This bill had a rider as a final clause, stating that the work should not be commenced until the Long Island R. R. had organized a company to construct the tunnel under the East River. Subsequent to this, in the session of 1898, a bill was introduced under the provisions of which, after the depression and completion of the improvements, as authorized by the bill of 1897, the Long Island R. R. Co. retained the right to operate street cars by electric or motive power other than steam on the surface of Atlantic Ave., the object of this being to operate surface cars in conjunction with the tunnel cars. This bill failed of passage.

At the session of the Legislature for 1899 three bills were introduced. The first of these bills repealed the city charter provision limiting the life of franchises to 25 years, etc., in the case of "tunnel railways underneath the surface of the streets," and authorized the Municipal Assembly to grant to such tunnel railways, at its discretion, franchises in perpetuity. The second bill provided for the proposed tunnel under the East River as planned, and the third bill provided for the removal of the Long Island R. R. tracks from Atlantic Ave. A notable provision of the last bill was one stating that where a company depresses its tracks it shall not lose its right to the surface of the streets, but may operate another road thereon with any motive power except steam. This bill also provided that the city should share equally with the railway the cost of removing the tracks from the surface of Atlantic Ave.

A very bitter struggle resulted over the passage of these bills, but more particularly regarding the first one mentioned, which repealed the present franchise provision of the city charter. The result of the struggle was that the first bill was amended to grant a 50-year franchise with the privilege of renewal for 25 years more, and all three bills were finally passed.

This bill was signed by the Mayor of New York, which leaves the road clear to begin the actual work of construction, which the officials of the Long Island R. R. have announced their intention to push as rapidly as possible.

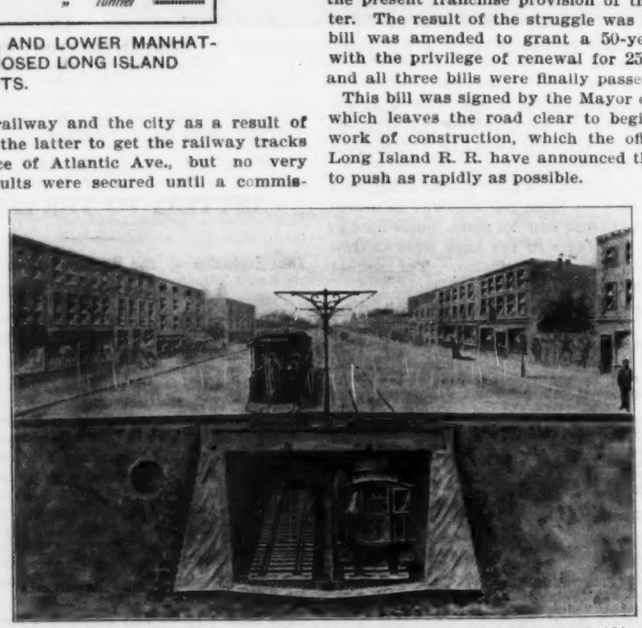


FIG. 2.—TYPICAL VIEW OF SUBWAY CONSTRUCTION FOR LONG ISLAND R. R. ON ATLANTIC AVE., BROOKLYN.

Atlantic Ave. Improvement.

The removal of the surface lines from Atlantic Ave. is to be accomplished partly by elevated structure and partly by subway. At Jamaica, Fig. 1, all branch lines connect into the main line of the Long Island R. R. Running west from Jamaica the line passes through Morris Park, where the Long Island City line leaves the Atlantic Ave. line, and thence through Woodhaven,

where connection is made with the lines to Rockaway. Proceeding west, Brooklyn is entered not far from Atkins Ave., where there is a summit in the profile of Atlantic Ave. From this summit the elevated structure runs so as to clear the next cross street and continues to Manhattan Beach Crossing, where the line comes to the surface again. The necessity for this return to the surface was that otherwise the entire grade of the Manhattan Beach Division would have to be changed, involving an expense so great that it was not warranted.

Passing west from Manhattan Beach Crossing the line descends into subway which continues to Ralph Ave., where the change is made again to elevated structure, which continues as far as Nostrand Ave. From Nostrand Ave. to Bedford Ave., which is 800 ft., the grade of the street is ascending, which facilitates passing again from viaduct to subway, which continues to the underground terminus at Flatbush Ave. The object of the depressed station is of course to facilitate the extension of the line underground on its way to New York. The depression below the surface of the street at this point is about 18 ft., and communication between the two levels will be accomplished by means of stairways and elevators.

At the Flatbush Ave. station the work of the commission for the improvement of Atlantic Ave. ceases. As already indicated, the work will consist in constructing alternate stretches of viaduct and subway, and by these means the removal of all steam railway tracks from the surface of the street. The final details of both the viaduct and the subway construction have been decided upon and approved, and will be published at a future date, but the accompanying view from a wash drawing of the proposed subway shows the general nature of the construction quite clearly. It will consist, as will be seen, of concrete side walls and invert carrying a roof of I-beams between which concrete arches will be sprung. The dimensions will be great enough for standard cars and locomotives.

The Tunnel Line.

The route of the proposed tunnel extension to Manhattan Island is shown by the map, Fig. 1, and also in more detail by the plan and profile, Fig. 3. Leaving the Flatbush Ave. station the location, as will be seen, follows Flatbush Ave. to Fulton St., and continues under Fulton St. to Pineapple St., with a station near the City Hall Square in Brooklyn. Passing under Pineapple St. and the East River the tunnel strikes Manhattan Island at the foot of Maiden Lane and crosses the city under that street and Cortlandt St. to the North River, where it will meet a tunnel running under the North River to the Pennsylvania R. R. terminus in Jersey City. This North River tunnel is in a rather uncertain state as yet, and it will not be referred to here again. Besides the station at City Hall Square in Brooklyn, there will be two stations in Manhattan, one of which will be located close adjacent to the Second and Third Ave. lines of the Manhattan Elevated R. R., and the other near the Sixth and Ninth Ave. lines of the same road. This last station will be the terminal station of the line until it is extended under the North River, and should the extension not be made an underground loop track will ultimately be constructed.

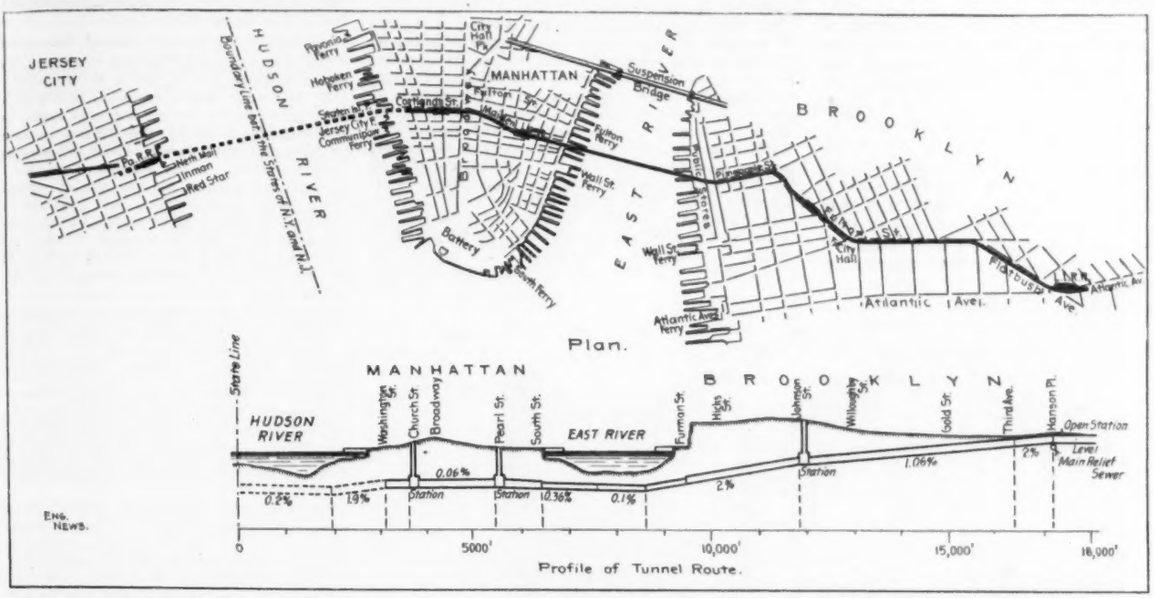


FIG. 3.—ENLARGED PLAN AND PROFILE OF LONG ISLAND R. R. TUNNEL EXTENSION TO MANHATTAN ISLAND.

The profile of the tunnel, Fig 3, has an approximately uniform grade from Flatbush Ave. to the deep point on the Brooklyn side of the East River. All the stations will be at summits of grade, so as to get the benefit of ascending and descending grades in stopping and starting trains. The depth of the tunnel below the surface was determined by the conditions affecting the Manhattan end. Here it was necessary, first, to be at such a depth as would enable the future extension to Jersey City, and also to run so far beneath the surface that there could be no possibility of disturbing the deep foundations of the numerous tall buildings in that section of the city. As planned the level of the tunnel is entirely below bed rock. This point being fixed, the next thing was to determine upon the depth of cover necessary between the bed of the East River and the top of the tunnel. It was finally decided that 30 ft. was depth enough, and with this point and the grade of the Manhattan and Brooklyn termini already fixed the remaining work was simply to connect them with suitable grades.

The cross-section was fixed in its dimensions and form by practical considerations. It was thought that there was no commensurate advantage either to the traveler or to the operating company in providing for a through surface of heavy railway coaches, when it was necessary in order to do so to increase both the size and strength of the tunnel and to decrease the safe operating speed. The tunnel was therefore designed for a special car, and the distance between centers of tracks was made 10 ft. 9 ins. As already stated, the material passed through on Manhattan Island will be solid rock. For the remainder of the tunnel under the East River and in Brooklyn the material penetrated will be glacial drift, composed of hard, rather impervious collection of sand, gravel boulders and clayey matter, which forms excellent material through which to tunnel. The cross-section adopted for the land portions of the tunnel is one which closely fits the cars, it being a double-track single tunnel, having an elliptical roof and an invert, both of brick. For the portion of the line under the East River two parallel circular tunnels, 14 ft. 6 ins. in diameter each, will be employed. These will connect with the land tunnel at each end by means of bell mouths. Figs. 4 and 5 show the two forms of cross-section described.

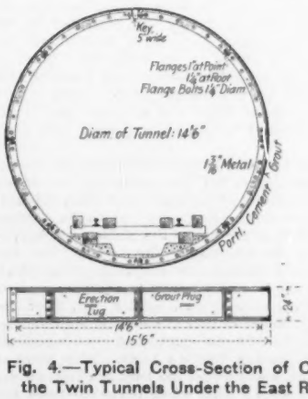


Fig. 4.—Typical Cross-Section of One of the Twin Tunnels Under the East River.

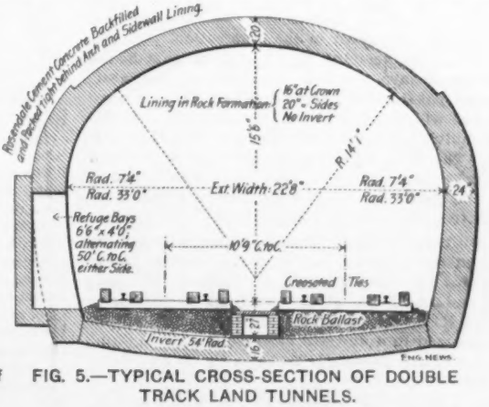


FIG. 5.—TYPICAL CROSS-SECTION OF DOUBLE TRACK LAND TUNNELS.

The reason for adopting the double circular tunnel for the East River section is a simple one. To take both lines of track in one tube it would have to be 22 ft. in diameter. This would mean about one-fourth more excavation and weight of material than the double tube tunnel. A more important feature than this, however, is that the smaller diameter of 14 ft. 6 ins, adds greatly to the safety and ease of construction. Compressed

air will be required for this portion of the work and a shield will probably be used in making the excavation. It is possible also that shields will be used in the portions of the land tunnel penetrating soft material. The methods of construction, however, have hardly been considered more than in a general way as yet, and may be left for a future discussion.

The stations constitute one of the most important features of the work, since they have to fulfill not only the ordinary station purposes, but have also to provide means of quick transit between the street and tunnel levels. Fig. 6 shows the tentative design which has been adopted. As will be seen, the surface station will be on one side of the street, and will be connected with the underground station by means of elevators and a stairway. The feature of these elevators is that each will have a capacity of a car load of passengers, and will have doors on both sides, all passengers descending to the trains entering on

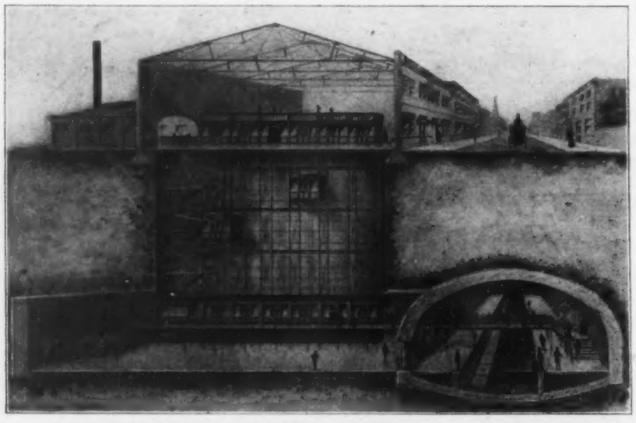


FIG. 6.—TYPICAL STATION ON LONG ISLAND R. R. TUNNEL EXTENSION.

one side and all ascending from the trains having egress upon the other side.

At the bottom of the shaft there will be two landings. The bottom landing will be on the level of the west-bound train platform, and passengers going west will leave the elevator and enter the trains while passengers coming from the west desirous of going to the street will enter the elevator on the other side. For the east-bound passenger platform the case required separate treatment, as no passenger must cross the tracks at grade. An upper landing was therefore placed at a height which enabled it to be extended over the tracks, as shown in the illustration. On this landing the incoming and outgoing east-bound passengers are handled similarly to the west-bound passengers below. While this general scheme will be adopted for all the tunnel stations the individual details of each will of course differ. The stations below ground will be finished in white enameled brick, and particular attention will be given to the lighting and ventilation of both the stations and tunnel lines.

As already stated, through trains will not be run on the tunnel line, but special tunnel trains operated by electricity will ply between Manhattan and the Flatbush Ave. station of the Long Island R. R. The schedule of these trains will be so arranged that one will meet each incoming and each outgoing passenger train on the Long Island R. R.

The cost of the improvement on Atlantic Ave is estimated at $2,500,000, of which the city and the railway company will each pay half. The tunnel is estimated to cost $6,000,000, all of which will be paid by the Long Island R. R. Co. The plans for both improvements have been prepared by Mr. Charles M. Jacobs and Mr. J. Vipond Davies, M. Am. Soc. C. E., the latter gentleman being the engineer of the Atlantic Avenue Commission. We are indebted to Mr. Davies for the matter from which this description has been prepared.

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The convention of the American Society of Mechanical Engineers, held at Washington, D. C., last week, was one of the most successful meetings in the numbers* in attendance, in the interest of the meetings and in the pleasure of the entertainment tendered to the visitors by their hosts that the society has ever held.

The first general gathering of the members took place on Tuesday evening, and was an informal reception by the President of the Society, Admiral Geo. W. Melville, held in the beautiful new Corcoran Art Gallery. The visitors were also formally welcomed in a brief address by Col. T. A. Bingham, Corps of Engineers, U. S. A., the officer in charge of Public Buildings and Grounds at Washington. Col. Bingham in the course of his address gave an interesting history of the city's chief landmark, the Washington Monument, and the engineering difficulties which were met in its construction.

On Wednesday morning, the first formal session was opened at the Arlington by the report of the tellers of election as to the new members just voted on, and the report of the finance committee. The latter document showed the society's finances to be in a highly satisfactory condition. The receipts for the first half of the current year were about $3,400 in excess of the disbursements. The society has purchased all but $5,600 of the bonds which were issued some years ago to aid in the purchase of its house in New York, and it is probable that the remainder will be acquired by July, 1900.

After the reading of a formal invitation to hold the next spring meeting in Cincinnati, and some routine business, the technical work of the convention was undertaken as follows:

Revision of the Society's Standard Code for Conducting Steam Boiler Tests.

The final report of the committee which has been engaged on this subject since 1897 was presented by Mr. Wm. Kent. Few changes have been made since the presentation of the report in its preliminary form, in which form it was printed in Engineering News of Dec. 1, 1898. This new set of rules for boiler testing will be known as the "Code of 1899," and will doubtless be accepted as the standard for all boiler testing work hereafter.

The report was discussed by Messrs. Kerr, Meier, Bryan, Hale, Suplee and Jones; but the discussion was merely upon minor detail points of the code. Prof. Kerr defended the Berthier method of calorimetry, which he thought might be preferable to the use of the Mahler calorimeter, recommended by the committee. Col. Meier and Mr. Bryan, of St. Louis, thought that a slightly greater draft should be called for in capacity tests to allow for practice in burning Western coals of poor quality. Mr. Kent, for the committee, promised to take the suggestions into consideration, but said that too much draft was sometimes an objection in burning Western coals. With some of these coals, if the fire is forced too hard the temperature of the fuel bed reaches a point where the ash is fused and forms a clinker, and the result is that the boiler shows a lower capacity than if a lighter draft has been used.

Reports of Committees.

Mr. F. H. Boyer, for the Committee on a Uniform Code for Steam Engine Tests reported that the committee was making good progress, and was receiving gratifying response from foreign countries, indicating that the hope of securing international adoption for the new code might be realized.

Mr. F. E. Frothingham, for the Committee on Junior Meetings, reported that meetings were held in March and April which were well attended and successful, and they are to be continued next winter, being held on the first Tuesday evening of each month (except December) at the Society's House in New York. The subjects for next winter's meetings, which have been already selected, are 'The Gas Engine," "Bearing Metal Alloys," "Cast-Iron Piping vs. Steel," and "Mechanical Stokers." Complete reports of the transactions at these meetings are made and filed in the Society Library.

Standards for Direct-Connected Generating Sets.

The first paper on the list with the above title was then presented by its author, Mr. J. B. Stanwood, of Cincinnati. The paper was a statement of the difficulties experienced under the present system of engine and dynamo production due to the fact that the two machines are built by different manufacturers, whose interests are not entirely the same. In the absence of standard sizes, designing engineers call for any size at random, necessitating special construction of both dynamos and engines, and yet giving no real advantage to the purchaser. He also pointed out that the adoption of such standards was almost a necessity to secure foreign trade in this class of machines. He concluded his paper with the following motion:

That the council be requested to communicate with the American Institute of Electrical Engineers to ascertain if that institute will agree to appoint a committee to co-operate with a similar committee to be appointed by the American Society of Mechanical Engineers, to determine upon and recommend a standard series of capacities, speeds, and necessary dimensions for electrical generators for direct connection to steam engines.

And, furthermore, if a favorable response be received, then the president be requested, with the concurrence of the council, to appoint a committee of the proper size to co-operate with the committee to be appointed by the American Institute of Electrical Engineers for the purpose herewith set forth.

The paper was discussed by several members, all of whom agreed that the author had by no means overrated the evils of the present situation, and that purchaser, engineer, engine builder and dynamo builder would all benefit by the adoption of the proposed standards. The motion of the author above quoted was thereupon put and carried unanimously.

Boiler and Furnace Efficiency.

In this paper, Messrs. R. S. Hale and W. S. Russell, of Boston, had tabulated the data from a great number of boiler tests in the endeavor to discover what proportion of the losses in a steam boiler are due to the furnace and what to the boiler itself. The paper represented a vast amount of labor, but the uncertainty as to the data used made the conclusions reached of doubtful reliability. We reprint these conclusions, however, as follows:

In designing or selecting a boiler, have the furnace roomy, and, if practicable, line it with brick in order to have a very high furnace temperature.

Pay especial attention to the furnace if poor coal is to be used. Get rid of air leaks after the gases have left the hot furnace. Proportion the boiler so that at least 15 lbs. of coal per sq. ft. of grate must be burned to develop its horse-power, and so to keep the rate of evaporation per square foot of heating surface low. This involves a moderately high ratio of heating to grate surface.

The horizontal return tubular boilers appear, all things considered, to be the best type of boiler for economy of steam production, although the internally fired boilers are probably as good if the furnace is roomy and the firing careful. The Thornycroft boilers, which (from a combustion point of view) is of this type, show the best result of all.

Certain of the water-tube boilers suffer from air leakage and from short circuiting of gases if underworked. Of course the advantages of water-tube boilers often make their choice advisable, even at the possible expense of a slight loss in efficiency. The Lancashire type suffers from air leakage, and the furnace is poor.

Stokers save nothing over hand-firing, either in better combustion or less air supply. This does not necessarily apply to all stokers, and it should be remembered that, even if it should finally prove to be true that stokers are no more efficient than hand-firing, yet saving in labor and smoke may pay good returns on their cost. Down-draft grates show up well, both in good combustsion and small air supply, but the number of tests is too few to allow final conclusions to be drawn.

The paper was discussed by Messrs. Roney, Meier and Kent, each of whom criticised the author's conclusions in one respect or another.

Test of a Steam Separator.

This paper, by Prof. F. L. Emory, of Morgantown, W. Va., described tests of an Austin steam separator. The results of the tests were summarized by the author as follows:

We would conclude that this separator in good condition and for the higher velocities of steam flow will deliver steam of say 97% dryness, and has little separating qualities in steam of dryer quality. And we are quite safe in concluding that it will, if kept well drained, deliver a steam dry within 3%. There seems to be little difference in its action for live steam from boiler and the exhaust steam or steam of low pressure of considerable wetness. The steam of 3 lbs. above atmosphere, corresponding to ordinary engine exhaust, was, as will be seen from its quality in the table, made to contain by means of the jacket considerable moisture, and again made quite dry. The action, however, was similar to that for steam of higher pressure and similar wetness, namely, to deliver steam of say 97%, irrespective of original quality.

The same separator was then tested to determine its efficiency in separating oil from exhaust steam. The result showed that about 52% of the oil on the average was

*The total number of members and guests registered was 577.

recovered as pure oil, although the emulsion of oil and water which might be used for lubrication again was a much larger amount. The paper was discussed by Mr. F. H. Boyer, who called attention to the fact that any of the oil separators on the market leave a large percentage of oil in the steam. He had obtained the best results by using beyond the ordinary oil separator a large closed-cylinder filled with coke, through which the steam is passed. When this coke becomes charged with oil, in the course of 10 to 30 days, it can be taken out and burned and a new charge put in.

This concluded the list of papers for the morning session. Before adjournment the president announced the nominating committee, which will report to the council, as follows:

C. W. Hunt, New York city; Geo. H. Smith, Providence, R. I.; A. K. Mansfield, Salem, Ohio; Henry I. Snell, Philadelphia, Penn.; W. A. McFarland, Pittsburg, Pa.

In the afternoon the visitors were photographed on the steps of the Navy Department Building, and then went to the White House, where they were shown through the famous rooms and the conservatories. Afterward they went to Arlington, crossing the Aqueduct bridge and crowding to and beyond its capacity the rolling stock of the electric railway which runs to Fort Myer and Arlington. At the latter place the famous old Custis-Lee mansion on Arlington Heights was opened to the visitors by special arrangement.

Investigations of Boiler Explosions.

The session on Wednesday evening opened with a paper on the above subject by Mr. Gus. C. Henning. The purport of the paper was that the cause of a boiler explosion could always be determined by an investigation, provided it were made with sufficient care and intelligence. The causes of boiler explosions he enumerated as follows:

a. Excessive Pressure.—This can be produced by wilfulness or by careless operation; it can be controlled by autographic recording gages, alarm whistles and competent management.

b. Defective Material.—This can be readily avoided, and should never be used in any case; it is criminal to use it.

c. Low Water.—This may be the result not only of carelessness, but of many accidental cases, such as derangement of pumps or injectors, stoppage of pipes, gage glasses, valves, etc., or even by suddenly augmented leakage, which cannot always be discovered promptly, or even immediately provided for after discovery.

d. Defective Workmanship.—This exists more or less in all boilers, except those which are built without calked seams and rivets, and punched holes, and all parts of which are prepared and finished by machine-tools and consist mainly of tubes with screwed ends. Defective workmanship develops greater or less defects during service and necessitates constant repair and patching, and may be cause of material weakness in course of time.

e. Local Defects.—This may exist in all boilers initially or develop after a while in service.

Mr. Henning would determine excessive pressure by testing thick and thin parts of the boiler, recording the results of the tests with an autographic recorder, and ascertaining the extent to which the yield point of the metal has been raised. "If calculations show that the augmentations of yield point in thick and thin material were produced by the same internal pressure, then it is proof positive that excessive pressure existed at the instant of explosion, and also its exact amount."

Defective material he determined by physical examination and by careful tests with autographic records. He claimed that long exposure of metal to contact with fire produces marked changes in the physical structure. The method of determining whether low water was the cause of an explosion, we print in full as given in the paper:

Low water, however caused, always produces excessive heating; and if the temperature rises sufficiently to weaken the material, failure may occur by stripping of the staybolts or rupture of the sheets by bulging between them, or otherwise. If the temperature has raised the material to a low or bright red color, this can be readily determined by superficial inspection. While the fire side will show red rust or a black color, the water or steam side will invariably show a typical steel-blue scale, which will not disappear even after years, as it is a so-called rustless coating. If this be once oiled it will always be distinguishable, even if the plates have been exposed to moisture and gases for years. The color of this scale will depend somewhat upon the temperature at which it was produced, being brightest at those points where temperature was the highest.

Carefully made tests, with autographic diagrams, of such material will again demonstrate changes of properties, which are very characteristic. The yield point will be found very low, while the diagram will show a material drop of curve just after the yield point. The elongation will, however, as a rule, be materially increased, with a diminution of tenacity. Nicked and quenched bending tests will again show marked differences between strips cut from the sheet at points which in one case were overheated or were above the low-water line, and in the other were taken from a part below this line. The fracture will also be materially different.

To demonstrate the temperature at which the plates happen to be at the instant of explosion, it is necessary to cut strips from points of the overheated plate below the water line. These strips polished on the edges are then held in a clear fire so that one end remains cold while the other is heated to a dull yellow or a very bright red. This temperature being reached the bars are withdrawn, and while one is rapidly plunged with one end into a pot of boiling water, the other is allowed to cool in air, but not in contact with wet material or metal or stone. When the piece which had been immersed in boiling water about one inch deep has become nearly cold, below blue heat, it is plunged into cold water.

On the polished edges of both bars will be found scale and heat colors, the temperatures producing them being well established. These bars are then carefully nicked at points opposite every change of color and then broken off at these nicks. By comparing these fractures and their scale and colors with those obtained from pieces cut from the overheated plates, the temperature at which they were at the instant of explosion can be determined with great accuracy. Having thus determined the temperature at which the sheets were during operation, it is also known whether the metal was sufficiently soft to bulge or to strip from the staybolts; examination of plates and bolts will verify the conclusion.

In concluding his paper the author repeated his convictions that "there does not seem to exist any doubt whatever that the cause of every boiler explosion can be readily determined by simple means readily obtainable, by one who has correct and sufficient knowledge of properties of materials as affected by different conditions.

The paper was briefly discussed by Messrs. McFarland and Aldrich.

Relation Between the Initial Tension and Power Transmitted by a Belt.

In this paper, Prof. F. L. Emory, of Morgantown, W. Va., gave a theoretical mathematical discussion of the initial tension required in a belt to transmit a given power. The paper was discussed by Mr. Wilfred Lewis, of Philadelphia, who showed that the author had omitted several necessary elements in the problem. He stated that the results of the extended tests made by Wm. Sellers & Co. was that to make the initial tension of a belt equal to its working load was a safe and comfortable rule for belts running at moderate speeds. At very high speeds, however, the effect of the centrifugal force has to be taken into consideration.

Experiences with Deep-Well Pump Rods.

Prof. G. W. Bissell, of the Iowa State College, described in this paper some of the troubles which he had found in operating a Johnson deep-well pump on the grounds of the college. The pump pistons are located 300 ft. below the ground level, and are operated by two strings of rods. The lower piston is worked by a string of rods of 1¼-in. round iron, with ends upset for a 1¼-in. thread, by which the rods are coupled together. These rods work inside a 2-in. pipe, which is connected to and operates the other piston. The pistons work against a head of about 370 ft., and the engine driving them makes about 30 revolutions per minute.

After this apparatus had been in operation a few months the inside rods parted and on removal were found to be badly worn at nearly every joint. They were removed and as the couplings on the outside rods also showed considerable wear, brass-winged guides were put in at intervals to keep the outside pipe from rubbing against the sides of the drop pipe. For the new inside rods extra heavy 1-in. pipe with special couplings smaller than the body of the pipe was used. These also were badly worn at the end of two months, and it was found that it was due to the rods being out of line at the joints. They were removed and carefully straightened, and have since been in service with fairly satisfactory results. Trouble was also experienced with the drop pipe, which was found to be due to a leak at a depth of about 200 ft.

The discussion on this paper was opened by Mr. F. H. Boyer, who said that he tried iron pipe for deep-well pump rods 15 years ago, but found that it was impossible to keep such rods straight, and the casing would sometimes be worn through in the space of a month. He finally eliminated all his difficulties by substituting wooden rods, making the couplings between them smaller than the body of the rod. President Melville said he had pumped from a depth of 1,200 ft. with a string of wooden pump rods, and would not think of using iron for deep-well pump rods, since the rods would inevitably rub against the sides of the casing and wear it through if iron rods were used. With wooden rods, the wood would wear instead of the iron, and the rods could be easily replaced when worn out.

Pipe Flanges and Their Bolts.

In this paper Mr. A. F. Nagle, of Chicago, severely criticised present practice in the matter of steam pipe joints, and discussed methods of overcoming the difficulties that are now experienced. He favored the provision of a tongue and groove in the bearing faces of the flanges to hold the gasket in place and prevent its being blown out. He also proposed a novel form of pipe, consisting of a thin copper tube with longitudinal corrugations; steel staves of peculiar section surrounded and supported this copper pipe. The bursting pressure was taken up by external hoops of iron or steel. This construction was criticised in the discussion which followed the paper as complicated, expensive and of doubtful merit. It was also pointed out that a tongue and groove in a pipe flange is always objected to by the pipe fitters, since it interferes with the removal of a length of pipe from the steam line.

After this the discussion took a wide range, and the whole subject of steam pipe joints was overhauled. Admiral Melville remarked that his department had more trouble from leaky steam pipe joints during the Spanish war than from any other single cause. The discussion was also participated in by Messrs. Supple, McBride, Kent, Boyer, Bolton and several others. Some of the most important points brought out can be summarized as follows:

The best form of pipe joints now on the market is that illustrated in Engineering News of March 23, p. 183, in which a very heavy flange is welded onto the pipe. Good results have been obtained, however, from pipe in which the lengths of pipe are expanded into the flange and the ends are turned over so that the joint is made between abutting faces of the pipe itself. In any pipe, provision must be made for expansion and contraction, or trouble with leaky joints may be expected. If gaskets are used in a joint, they should not be too wide, and the joint should be made on the inner side of the face. Very heavy flanges—two or three times the ordinary thickness—and plenty of stout bolts to hold them together, are a necessity if joints are to be kept tight under high steam pressure.

The Manufacture of Car Wheels.

This excellent and interesting paper by Mr. Geo. R. Henderson, formerly Mechanical Engineer of the Norfolk & Western R. R., and now with the Schenectady Locomotive Works, was read by the secretary in its author's absence. We shall reprint parts of it later. There was no discussion offered, and it was voted to hold the paper open for discussion at the next meeting of the society. This closed the work of the evening session.

Equipment of Tall Office Buildings in New York City.

In this paper, with which the session on Thursday morning was opened, Mr. R. P. Bolton gave some account of the circumstances which have brought about the "sky-scraper era" on lower Manhattan Island, with a general statement of the engineering difficulties experienced in the mechanical equipment of these buildings and the methods of overcoming them. Mr. Bolton favored the practice of installing an independent mechanical plant for a large building instead of relying on the steam companies and the electric lighting companies for heat and power. Land in lower New York sold as high as $330 per sq. ft. in 1882, and most of the high buildings already erected are on land worth $150 per sq. ft. or more. The increased office area added to downtown New York by the increased height of recent office buildings is set by Mr. Bolton as 7,500,000 sq. ft. The cost of average steel-framed 16-story office buildings completed with equipment and with moderate exterior decoration he placed at 30 to 40 cts. per cu. ft. of their gross contents, outside measurement. The mechanical equipment, including everything pertaining to light, heat, sanitation and elevator service is about one-seventh of the total cost, and from one-third to one-half of this is for the elevators.

The paper was discussed by Mr. W. H. Bryan, of St. Louis, and Mr. E. P. Roberts, of Cleveland. The former had also found it cheaper to install isolated plants than to purchase current from central stations. The only exception was a special contract, where a building required elevator service at a time of day when the city lighting companies were running with only light loads, and a contract for service was made on the basis on 2½ cts. per K-W. hour used. Mr. Roberts said that owners were getting poor results in the mechanical equipment of their buildings; in many cases because neither they nor the architects appreciated the importance of thorough engineering work in the design and construction of such equipment. He thought the future might see a considerable increase in the use of gas engines and storage batteries for isolated electric lighting plants in large buildings.

Rolling Mill Fly-Wheels.

In this paper the venerable John Fritz, Past-President of the Society, described the history of the development of fly-wheels for rolling mills, and illustrated a wheel which he had developed for this service which has been in service for many years, with perfect satisfaction. Describing the great strain to which wheels for rolling mill work are at times subjected, Mr. Fritz said:

Let us for a moment think of a fly-wheel 26 ft. in diameter, 16-in. rim, making from 70 to 80 revolutions per minute, rolling a steel bloom into a rail. When about one-half done, say, about 16 ft. in length, instead of the piece going straight out, through the rolls on the guides, as intended, it sometimes wedges in the groove, and in less than a second of time it has completely encircled the roll, and forms what in rolling-mill phrase is called a collar, and continues to wind around the roll until something must happen, either the breaking of a roll, a spindle or coupling, or the engine must be brought to a standstill in an almost incredible short space of time. The torsion on the spindles and couplings is so great that it causes the wheel to rebound. To calculate the strain the wheel is subjected to under these conditions will require someone better posted in mathematics than I am.

This paper started a long and rather rambling discussion on flywheel design in general. The consensus of opinion, however, was that the frequent breakages of flywheels were a disgrace to the engineering profession, and could be overcome by the introduction of correct design, good workmanship and plenty of material put in the place where it was needed. The need of great care in cooling large flywheel castings was set forth, and Mr. Fritz remarked that such casting should not be exposed at all. "After it is poured, put all the sand you can get on top of it, and leave it there until it is cold."

So much time was consumed in this discussion that it became necessary to adjourn for dinner, and leave a large number of papers still untouched for the closing session.

In the afternoon, the visitors assembled at the Washington Navy Yard, and were escorted through the well-

known gun shops, where were witnessed the assembling, boring, rifling and turning of built-up guns of all sizes. In the museum were seen a dozen or more large guns rescued from the Spanish vessels destroyed in the battle before Santiago. The greatest attraction to the visitors, however, was the new testing tank in which vessel models are to be tested as an aid to the naval architects in the design of hulls. An exhibition run was made with a goodly number of visitors on the traveling bridge which hauls the car and the working of the various parts of the apparatus was thoroughly inspected. The remainder of the afternoon was spent in visits to the power house of the Capitol Street Railway Co., which was illustrated in our issue of Jan. 26.

On Thursday evening occurred the principal social event of the convention—a reception tendered to the members of the Society, by Mr. and Mrs. George Westinghouse at their residence, the Blaine mansion. Mr. Westinghouse is now abroad; but Mrs. Westinghouse received the guests, assisted by Admiral Melville, Mr. and Mrs. B. H. Warren and others. A large addition had been constructed at the side of the house to provide room for the great number of guests; and its walls and high arched ceiling were completely covered with draperies of white silk, white roses, ribbons and trailing vines, in which were interspersed myriads of miniature electric lights which made the whole scene as enchanting as a bit of fairyland. The guests at the reception included not only the engineers, but many officers of the army and navy, members of the Diplomatic Corps and other residents of Washington, whose names have a national fame. Certainly no more elaborate entertainment has ever been tendered to the Society in its native land.

The late hours of Thursday night did not prevent the last session on Friday morning from opening with commendable promptness; and there was need of it, for seven long papers had to be disposed of in some way and an early adjournment was necessary on account of the afternoon's excursion. Two of these papers were descriptions of central light, heat and power stations for Universities. Prof. Storm Bull described the power plant at the University of Wisconsin, and Mr. E. A. Darling that of Columbia University in New York city. The latter was a paper of some 58 pages in length with many large plates, and is a valuable monograph upon its subject, but far too extended to admit of any satisfactory reproduction in these columns. Professor Bull's paper told of how various problems were solved at Madison, and how a plant by no means ideal was finally evolved, as a compromise representing the best that was possible under the circumstances.

These two papers were discussed by Messrs. Bolton, Bryan, Kent, Oberlin, Smith, Aldrich and others, and at request of Admiral Melville, the debate was turned upon the general question of the relative merits of isolated plants as compared with central stations, for supplying a group of large buildings. A problem of this sort is now under consideration for the Brooklyn Navy Yard. Perhaps the best point brought out in the discussion was the remark of a member that an engineer had no business to have a prejudice in favor of any system. His duty was to take each problem presented to him and give it the best solution possible. Laying down a hard and fast rule to fit all cases, and following "fads," are at the bottom of a great deal of defective engineering work.

Two papers on elevators were next in order, one on "The Plunger Elevator," by Prof. Geo. I. Alden, of Worcester, Mass., and the other by Mr. Chas. R. Pratt, of the Sprague Electric Co. Prof. Alden took the ground that the old-fashioned direct-plunger elevator could be adapted to the high speeds and exacting requirements of modern high buildings. He pointed out that a large part of the plunger is in tension and not under compression, as is commonly supposed. Mr. Pratt's paper was partially historical, but had special reference to the development of the Sprague-Pratt electric ball-bearing screw elevator, the most important installation of which was illustrated and described in our issue of April 27.

Owing to lack of time, only brief discussion of these papers took place.

The two final papers of the convention were "The Allen Valve for Locomotives," by Mr. C. H. Quereau, of the Denver & Rio Grande, and "A New System of Valves for Steam Engines and Air Compressors," by Mr. Fred. W. Gordon. Mr. Quereau's paper was a demonstration of the advantages of the Allen valves when properly applied. Mr. Chas. T. Porter gave an interesting bit of history as to the origin of this valve and the manner in which it was received by railway officers, and Mr. Rogers pointed out the advantage which the valve gained through the improvements made by the late H. W. Richardson, of Troy.

Mr. Gordon's paper described an ingenious and interesting departure in steam engine design, which we hope to illustrate and describe shortly.

This concluded the technical work of the convention, and the rest of the session was devoted to the passage of a large sheaf of resolutions, in which suitable acknowledgment was made of the many courtesies which had made the Washington meeting one long to be remembered. Among other resolutions the following was adopted, and is worth record here:

Resolved, That the association, as a body and through its individual members, urge upon Congress the necessity of relieving the present overcrowded condition of the Patent Office and providing sufficient room, force and facilities for the prompt and proper execution of its work.

Resolved, That we further urge that the records of the office, which so largely constitute the legal evidence of title of so many of the large manufacturing industries of this country, should be more safely stored, and that ample appropriations be made for providing incombustible receptacles for the records.

Resolved, That we especially urge that the library of the Patent Office, upon which the efficiency and accuracy of the work of the bureau depend, shall have such ample appropriation for its extension in its special field and for keeping it fully abreast of the progress in the mechanical and manufacturing arts of the day.

Resolved, That this association urge the necessity of giving to the Patent Office the use of the entire building in which it is now located, and that the moneys paid into the Patent Office by inventors be applied so far as necessary to the uses of the office.

In the afternoon came the closing excursion, and by all odds the most enjoyable of the afternoon outings, during the stay in Washington—a steamer trip down the Potomac to Mount Vernon. The place and the many historical relics exhibited there are full of interest to every American, and as token of their patriotism the Society carried with them an elaborate wreath, which was placed on the tomb of Washington. It may be of interest to note here a fact with which some of our readers may be familiar, that a compass used by Washington in his practice as a surveyor is among the relics kept in the Mount Vernon mansion.

The last evening in Washington was a busy one, for visits both to the Monument and to the Congressional Library were upon the program. At the latter place, the Superintendent of the Building, Mr. Bernard R. Green, exhibited to the visitors the mechanical equipment of the building, and the apparatus by which books are distributed from the labyrinth of stocks to the central desk, and carried back and forth through an underground tunnel to the Capitol. But far and away beyond the interest of these pieces of mechanical ingenuity was the sight presented by the illumination of the great dome which covers the rotunda. We risk little in saying that that scene represented the culmination of architectural beauty that has yet been reached on this continent. It formed a fitting climax to the Washington meeting, which if it was less notable for the profundity of its professional papers and the importance of its set discussions than some meetings in former years, will outshine them all in the pleasure which it gave to the aesthetic sense of all who had the good fortune to attend it.

WEATHER TABLE FOR APRIL, 1899 (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.)				Wind.			Precipitation—Rain or melted snow. (Inches.)		
						Velocity in miles per hour.		Direction at time of max. velocity.			
		Average.	Max.	Min.	Range.	Average.	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	40.0	85	9	76	8 1	32	NW	1.20	0.69	10
	Portland, Me.	43 8	71	25	46	7.0	30	NW	1.55	1.09	6
	New York City	49.6	77	31	46	14.5	59	E	1 23	0 91	4
	Pittsburg, Pa.	55.0	88	25	63	5 2	20	S	2.59	1.27	10
	Chicago, Ill.	50.0	88	18	70	17.3	60	S	0 14	0.06	5
	Omaha, Neb.	50.6	84	17	67	9 5	36	S	1.73	0.82	8
	St. Paul, Minn.	47.6	81	12	69	7.8	30	NW	1.35	0 96	8
	Duluth, Minn.	39 9	69	13	56	10.1	36	NE	1.33	0.78	8
	Bismarck, N. Dak.	39.8	78	−3	81	11.0	42	NE	1.31	0.68	9
	Average.	46.3	80	16	64	10.1	38	—	1.38	0.81	8
Southern Cities.	Washington, D. C.	54.2	82	27	55	7.3	34	NW	1.54	0.93	4
	Louisville, Ky.	58.4	89	27	62	9.0	30	NW	3.50	1.37	10
	St. Louis, Mo.	57.8	91	25	66	9.5	39	SE	1.98	0.76	10
	Savannah, Ga.	63 4	86	38	48	10.5	36	NW	1.71	0.47	8
	Kansas City, Mo.	53 9	86	22	64	9.9	39	SE	3.31	1.02	8
	Jacksonville, Fla.	66.0	85	41	44	8.7	38	SW	3.21	2.60	5
	Chattanooga, Tenn.	59.2	87	34	53	8.1	28	SE	6.07	3.96	10
	New Orleans, La.	66.6	86	45	41	9.2	31	N	1.56	1.09	6
	Memphis, Tenn.	62.0	90	36	54	11.0	33	NW	1.38	0.56	10
	Palestine, Tex.	64.7	91	37	54	9.1	28	SW	2.81	1.08	7
	Average.	60.6	87	33	54	9.2	34	—	2.71	1.38	8
Western Cities.	Helena, Mont.	40.9	70	14	56	9.1	39	SW	0.70	0.40	9
	Port Crescent, Wash.	43.6	69	30	39	5.0	24	SW	3.53	1.40	20
	San Francisco, Cal.	54 6	80	43	37	11.7	38	W	0.62	0.45	5
	Salt Lake City, Utah.	50.6	80	30	50	7.4	51	NW	0.81	0.48	5
	Santa Fe, N. Mex.	49.1	71	23	48	8.1	43	SW	0.25	0.11	5
	Denver, Colo.	48.8	79	15	64	10.0	48	NW	0.75	0.35	5
	Yuma, Ariz.	71.6	100	46	54	—	38	W	0.00	0 00	0
	Average.	51.3	78	29	49	8.6	40	—	0 95	0.46	7

THE CARNEGIE INTERESTS that are to be transferred to the new $500,000,000 syndicate, says the "Iron Trade Review," include the Edgar Thomson Works at Bessemer, Pa., with its three separate plants; the Duquesne Works, with two plants; the Homestead Steel Works, with four plants at Munhall, Pa.; the Carrie blast furnaces, at Rankin, Pa.; the Lucy furnaces, at Pittsburg; the Lower Union Mills, at Pittsburg; the Lorimer Coke Works, Lorimer, Pa.; and the Youghiogheny Coke Works, at Douglas, Pa. He also transfers all the stock in the Carnegie Natural Gas Co., the Youghiogheny and the Trotter Water Companies, the Slack Water R. R. Co., the Youghiogheny Northern R. R. Co., and half the capital stock of the Pittsburg, Bessemer & Lake Erie R. R. Co. He includes all the coal and coke properties of the H. C. Frick Coke Co. in Fayette and Westmoreland counties, covering 40,000 acres of unmined coal, 20,000 acres of surface lands, 11,000 coke ovens, 2,500 railway cars and 3,500 dwellings. There is also all the stock of the Pittsburg & Conneaut Dock Co.; 43.6% of the stock of the Pennsylvania & Lake Erie Dock Co.; 25% of the New York, Pennsylvania & Ohio Dock Co.; 83% of the stock of the Oliver Mining Co.; all the stock of the Pioneer Mining Co.; 50% of the stock of the Pewabic Co.; 89% of the Lake Superior Iron Co.; 98% of the Security Land & Exploration Co., and 75% of the Pittsburg Lime Co. The total output of finished material of the Carnegie Steel Co., for 1899, is estimated at 2,500,000 tons. In 1898 this company's pig-iron production represented 17% of the output of the United States and 30% of that of Pennsylvania. The above interest is a very good showing for the accumulations of a man only about 64 years of age, and who commenced life as a telegraph operator in Pittsburg about 50 years ago.

PHOTOGRAPHIC SURVEYING, says M. Laussedat in a late paper to the Paris Academie des Sciences, originated in France almost immediately after the discovery of the process by Daguerre. Arago and Gay Lussac both foresaw the possibility of using the camera for topographical surveying, but progress was hindered by the then crude development of the art. In Europe, at the present day, some of the best work of this type is done in Italy and Austro-Hungary, and Germany adopted the method to a limited extent, in the war of 1870-'71, for surveys around Strasburg and Paris. A Photogrammetric Institute was later established at Berlin; the work of which is chiefly devoted to preparing plans and elevations of national monuments of Prussia and other German states from specially made photographs. Canada, however, has made photographic surveys on the largest scale of any country. Mr. E. Deville, the Surveyor General of Canada, has thus made one map covering 1,350 sq. miles to a scale of 1-80,000 in.; the territory thus mapped is intended for impounding reservoirs for irrigation purposes. The basis of the survey was an ordinary triangulation, and the points thus fixed were used for photographic stations. The Klondike region, about Dawson City, has been surveyed in this way, and plotted at Ottawa from the photographs taken by Mr. Ogilvie. The heights of the three photographic stations used were determined by aneroid readings; they were 2,870, 3,700 and 3,450 ft. above sea level.

THE WATKINS MOUNTAIN ANEROID is a modified form of aneroid invented by Col. H. Watkins, of the British Army, and made in England. The older aneroids, when carried to higher points, read lower than the mercurial barometer, or lose; and the greater the time it is kept under low pressure the greater is the loss, though when returned to normal sea level pressure, they will gradually recover this loss and read accurately. The Watkins aneroid is so constructed that the corrugated disk is put in action when required, and thrown out of action when not required for use. To do this the lower part of the vacuum box, instead of being fixed, is free to rise and thus relieve it of any strain. When it is to be used a fly-nut is screwed up as far as it will go, and the instrument is thus brought into the position for which it is graduated. In 1898, actual comparisons between it and mercurial barometers, in Switzerland, showed that the new form was about as good as the mercurial barometer, says the "Monthly Weather Review," of Washington.